

Fitzgerald (D)

al

Evaporation.
Army and Medical Museum

Cmpts. of

Desmond Fitzgerald

AMERICAN SOCIETY OF CIVIL ENGINEERS.

EVAPORATION.

BY

DESMOND FITZGERALD, M. Am. Soc. C. E.



AMERICAN SOCIETY OF CIVIL ENGINEERS.

INSTITUTED 1852.

TRANSACTIONS.

NOTE.—This Society is not responsible, as a body, for the facts and opinions advanced in any of its publications.

340.

(Vol. XV.—September, 1886.)

EVAPORATION.

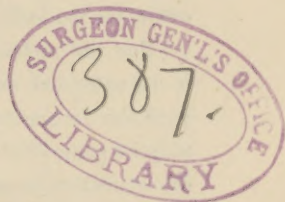
By DESMOND FITZGERALD, M. Am. Soc. C. E.

READ MARCH 17TH, 1886.

INTRODUCTORY.

Nearly two years ago the writer received an invitation from the American Society of Civil Engineers to submit a paper upon Evaporation at its last annual convention. Having already experimented upon the subject for several years and accumulated a certain mass of data, the invitation was accepted, under the supposition that it would not prove a very difficult task. On reviewing the whole subject, however, it became evident that a more extensive series of experiments would have to be entered upon than any previously undertaken, to throw light upon certain points which will appear in the course of this paper. These were at once begun and have been prosecuted diligently ever since. The theoretical side of the question was surrounded with so many difficulties, that the writer found it necessary to experiment in many branches of meteorological work in order to arrive at correct conclusions. The larger part of these experiments being more in the nature of preparatory work, are not alluded to at all in this paper. Before proceeding

presented by the author -



further, the writer desires to acknowledge his indebtedness to the Boston Water Board for the liberality with which they have allowed these experiments to be prosecuted, and to Mr. Fred. Brooks, M. Am. Soc. C. E., for material assistance received in the preparation of this paper.

As will be seen, the experiments and discussions are confined principally to the natural evaporation from water surfaces.

The importance of this subject may not appear at first glance, for it is only after a considerable course of study that the breadth of the field becomes visible. It is desirable for the hydraulic engineer to know, with more precision than is generally practicable, the approximate loss from water surfaces in the course of the year, for there are many estimates made in which this amount is really guessed at.*

For the meteorologist, who surveys a wider horizon, the path to a more extended solution of many of the difficult problems connected with the formation, distribution and condensation of vapor in the air may be somewhat smoothed, if, in addition to pointing out the amount of natural evaporation under given conditions, the laws which govern this amount can be demonstrated with considerable exactness.

PART I.

INVESTIGATION OF THE LAW OF EVAPORATION.

Considering the importance of the subject, comparatively little has been written on the theory of evaporation. There is undoubtedly a great deal of valuable matter scattered through various scientific periodicals, principally relating to the several meteorological phenomena connected with evaporation, but the terms employed to signify the same things are so diverse, and the methods of treatment so different, that much perplexity must necessarily result from their study.

It will be impossible in the limited space which has been set aside in this paper for the theoretical portion of the discussion, to attempt anything like a complete or scientific review of the theories or facts connected with evaporation, even were the writer fitted for the task. But it seems desirable to present, as briefly as practicable, some of the prin-

* The evaporation from the Ganges Canal in Northern India was estimated on the basis of the "Roorkee" experiments to amount to 47 cubic feet per second, but from what the writer has been able to learn of these experiments, the engineers must have been very much disappointed in the results.

cial facts which it is absolutely necessary to understand in order to get an idea of the subject.

In accordance with the dynamical theory of the constitution of bodies,* evaporation is constantly taking place at a rate due to the temperature at the surface, and condensation is likewise going on from the existing vapor in the air passing into the water, the difference between the two processes being what we call the rate of evaporation.

If a little water be introduced into the vacuum over a barometric column of mercury, the vapor which immediately forms will expand with a force due to its temperature and cause the mercury to fall to a point which forms the measure of the expansive power of the vapor. If now the temperature of the vapor be raised by applying heat, the mercury will fall still more; while on the other hand, if the temperature be lowered, the force of vapor becomes less and the mercury rises. In this way the maximum forces of vapor may be expressed in inches of mercury. We owe to the admirable experiments of V. Regnault an accurate table of maximum forces of vapor for different temperatures.

These values form the basis for almost all the tables in which humidity plays a part. They were made at the expense of the French Government, and will be found fully described in the Memoirs of the French Academy.

All air found in a natural condition contains more or less of this gas which we call vapor. Even the dry air blowing over a heated desert contains a small amount, and it is this amount which largely influences the rapidity of evaporation.

The rate of evaporation depends upon the difference between the maximum force of vapor due to the temperature of the water and the force of vapor existing in the air. If the force of vapor actually present in the air be small and the temperature of the water be high, evaporation will proceed with great rapidity, and, on the other hand, the rate will be diminished as the two forces approach each other in value.

It is necessary not to fall into the error of supposing that the rate of evaporation from a pool of water bears any direct relation to the relative humidity of the air. This might be the case if the temperature of the water surface followed the air, even approximately, in its changes of temperature. Many writers of the highest reputation have evidently assumed this to be the case.

* Wm. Garnett, *Enc. Brit.*, Vol. VIII, p. 732.

Let us examine somewhat closely into this matter of relative humidity, and see what it really is, and what its relations to evaporation are. Space has a capacity for vapor depending upon its temperature, so that if there is a given definite amount or weight of vapor in the air at a certain temperature, the relation which this vapor bears to the whole vapor-carrying capacity of the air is very different from the relation which the same amount of vapor bears to the carrying capacity of the air at another temperature. This relation is commonly called the relative humidity. This relative humidity is a capital measure of the effect on our senses of the humidity of the air, for at a given temperature and with a certain amount of vapor the air may seem very damp, while at a higher temperature, and with exactly the same weight or force of vapor, the same air may seem very dry. It has been shown by many celebrated physicists that air of a given temperature becomes saturated when there is a certain amount of vapor present, and it can be made to take up no more vapor unless its temperature be raised. Any surplus vapor must be condensed. This vapor present in the atmosphere has, as a gas, a certain pressure, or tension, or force, whichever term we care to use to express the same thing, dependent entirely upon the temperature.

The following will be found to be the changes which ordinarily take place in humidity during a day. In the latter part of the night, say at 4 A.M., the air is chilled to its minimum temperature, and supposing always that there is a certain definite force of vapor in the air—and, as a matter of fact, it does not differ so very much in amount from hour to hour, at any rate not sufficiently to affect our discussion—we shall then have a very large relative humidity, perhaps little short of saturation. The air, to the senses, will then appear to be not only cold, but damp. As the sun makes its appearance and warms the air, the relative humidity decreases, until at 2 P.M., a common hour of maximum temperature, the relative humidity is at its lowest point. The force of vapor, however, may be, and we here assume it to be, the same in both cases. By glancing over the table of hourly observations, the exact amounts commonly found at different hours may be seen, and the profiles, Plate LXXXI, give in a graphical form, for three successive days in July, all the meteorological changes from hour to hour.

Now, if the temperature of the water be the same at 4 A.M. and at 2 P.M., the hours under consideration, evaporation will be going on at exactly the same rate. An examination of the diagrams plotted by a

recording instrument, one of which is given, Plate LXXXVI, shows very little difference in the rate of evaporation at different hours of the day, as we might expect from the foregoing.

The following example, taken from the hourly readings of June 23d and 24th, 1885, will illustrate the above point. From 8 to 9 P.M. the mean relative humidity was 68 per cent. and the mean force of vapor in the air 0.311 of an inch of mercury. From noon to 1 P.M. the mean relative humidity was just half the former, or 34 per cent., and the mean force of vapor 0.305. The rate of evaporation was about the same during both hours.

If the temperature of the air be at any time lowered to a point where the vapor present would begin to condense; or, in other words, where the air would be fully saturated by the amount of vapor present, that point is called the dew point. If we know the temperature of the air and of the dew point, all of the other hygrometrical conditions may be easily computed. The dew point is a most important factor in evaporation, for as the dew point varies, the force of vapor varies, and, other things being equal, it is the difference between the temperature of the water and of the dew point that determines evaporation. If the water be cooler than the dew point, no evaporation can take place; on the contrary, the cooler water would condense some of the vapor in the air. But if the dew point be lower than the temperature of the surface of the water, evaporation must be taking place.*

The practical determination of the force of vapor in the air, or of the relative humidity, or of the dew point, is generally made by observing the difference between the wet and dry bulb thermometers; but from many observations made by the writer during both summer and winter, he is led to doubt the accuracy of common readings of these instruments. A more trustworthy method of securing good results is to take a direct observation of the dew point by means of some condensing apparatus, of which there are several good forms; but the use of such instruments is certainly far from convenient.

We have now reached a point where we may tabulate intelligently the principal points to be considered in the study of the vapor of the atmosphere, and we can hardly do better than to follow the order used by Buchan.†

* The difference between the temperatures of the air and of the dew point is called by some writers the complement of the dew point.

† Article "Atmosphere," Enc. Brit.

They are:

1. The temperature of the air.
2. The dew point.
3. The force of vapor.
4. The quantity of vapor in, say, a cubic foot of air.
5. The additional vapor required to saturate a cubic foot of air.
6. The relative humidity.
7. The weight of a cubic foot of air at the pressure at the time of observation.

Numbers 3 and 4 may be taken as approximately the same.

To John Dalton, a most accomplished philosopher, is due the credit of first pointing out in an approximate form the measures of the maximum forces of vapor. His experiments have been termed "slovenly," and they are certainly lacking in the accuracy of experimenters who have followed in his footsteps. Dalton's work was to discover many grand truths which others have spent their time in defining with accuracy.

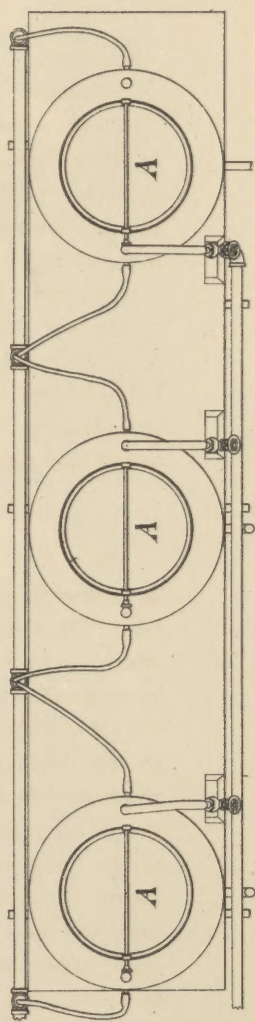
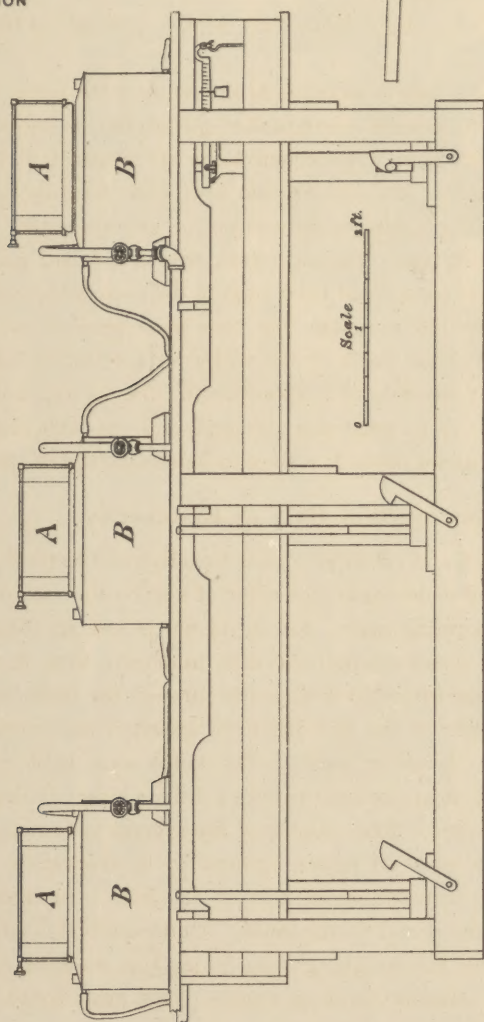
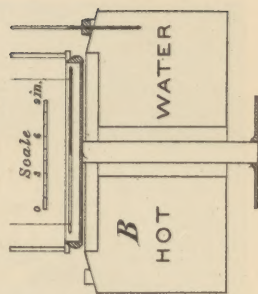
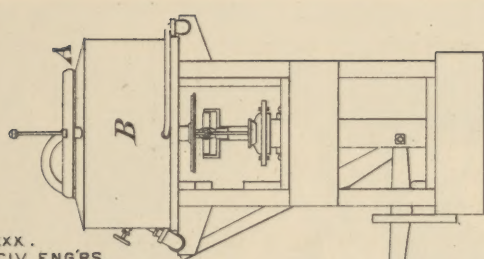
He was the first to ascertain the true principles of evaporation. From some observations made by the writer on the Dalton law, he was led to believe that the rate of evaporation in calm air was not in exact proportion to $(V-v)$ as generally accepted, and the following experiments were made under cover in a shop to determine the relation.

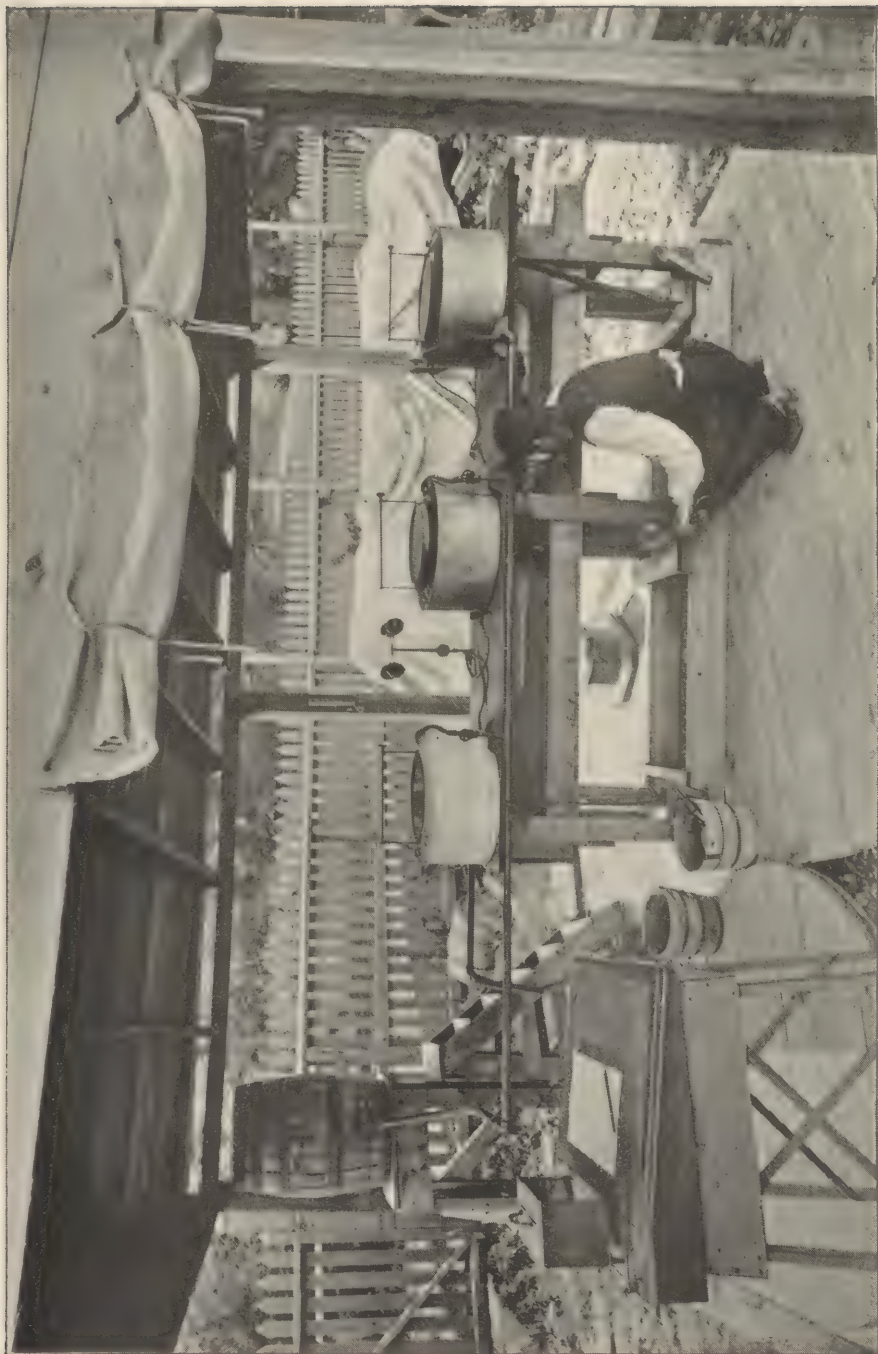
INFLUENCE OF HEAT ON EVAPORATION.

Plates Nos. LXX and LXXI give plan, elevation and sections of special apparatus designed to determine the effect of heat on the rate of evaporation. Three evaporating pans, *AAA*, 14.85 inches in diameter (in which 1 ounce of water equals 0.01 inch in depth), were fixed on the brass spindles which extended downwards through the tanks *BBB*. At the lower extremities of the spindles were attached plates which fitted on to a Fairbanks' weighing scale. The tanks were kept full of hot water at different temperatures, supplied from a steam boiler through the pipes, as indicated. The bottoms of the evaporimeters and the tops of the tanks were made of plates, ground to fit accurately, so as to insure the equal distribution of heat to the pans. In their normal positions these pans rested on the tanks. Underneath this apparatus a small track carried the weighing scale, which was mounted on trucks and graduated to one-eighth of an ounce. This scale could be rolled successively under each of the pans, and by pressing on a lever

Evaporating Pans.

PLATE LXX.
TRANS. AM. SOC. CIV. ENGRS.
VOL. XV NO. 340
FITZGERALD
ON EVAPORATION





both pan and scale were raised slightly and the weight of the pan taken. The objects of the apparatus were to keep each evaporometer at some definite temperature for several hours, and to weigh the water at given intervals without spilling the contents, and so quickly as not to change the temperature materially.

The thermometers were suspended by very fine wires, so that the whole length of a glass was just beneath the surface. A screw permitted the lowering of the thermometers as the water evaporated. The temperatures were recorded every 10 minutes to the nearest 0.1 degree C., and the weights taken every half hour.

Psychrometers were read at the same time. By keeping the three pans at widely different temperatures at each experiment, the effect of temperature could be noted independent of other conditions.

Table No. 4 gives the results of 154 experiments.

As this work progressed the observations were plotted on a large scale, as a working drawing for aiding the study of the effects of varying temperatures. The values of $(V-r)$ were taken as the abscissas and the evaporation in decimals of an inch per hour as the ordinates.

V in this paper means the maximum force of vapor in inches of mercury corresponding to the temperature of the water; r the force of vapor present in the air; and E the evaporation in inches of depth per hour.

Simultaneous observations were connected by lines of the same color for facilitating the comparisons. Plate No. LXXII contains all these experiments on a small scale, with the mean curve as finally adopted. All of the circles were not given equal weight in determining the curve, as it was found that the position of one of the pans near a somewhat open partition in the room where the experiments were made seemed to have a slight influence on the rate of evaporation. This irregularity was investigated by special experiments.

In order to ascertain whether any lateral or other currents of air were set in motion by increased temperature in one pan which were not felt in the others, cloth hoods 6 feet in height were used during a portion of the observations. These screens surrounded the tanks, and were used both open and closed at the top, but no effect on the curve was noticed. Other experiments were tried, such as keeping different depths of water in the pans, changing thermometers, and the relative position of the pans, etc. The mathematical expression of the curve is

$$E = .014 (V - v) + .0012 (V - v)^2.$$

THE EFFECT OF WIND.

When a water surface is exposed to the movements of the air we find that the velocity of the wind ranks in importance next to the difference in the forces of vapor as influencing the rate of evaporation.

The exact effect has never been determined so far as the writer can ascertain. Dalton found that a strong wind doubled the result produced in a still atmosphere, and his tables contain the corrections to be made for a moderate breeze and a brisk wind.*

In order to measure the influence of the wind with more precision, the evaporating pans were moved out into the open air. An anemometer was placed with the cups at the same level with the water in the evaporators, and the temperatures, weights and forces of vapor were recorded as in former experiments. Table No. 5 gives the results. The range of velocities was not so great as the writer would have liked, but there are many difficulties in the way of experimenting in high velocities, such as water blowing out of the pans, incorrect weighing, etc.

As confirmatory of the general accuracy of the curve, it was found that the increased rate of evaporation for higher values of $(V-r)$ was seen in the experiments in the open air as well as in those in the shop, so that it cannot be supposed that the greater evaporation from warmer water was due to air currents that heat might have started.

These wind experiments were plotted on the same scale as the former ones, with $(V-r)$ as abscissas and the evaporation as ordinates. The plotted lines connecting simultaneous observations when the wind was constant for all the pans then exhibited the way in which the evaporation varied with different values of $(V-r)$. By following the lines corresponding to particular values of $(V-r)$ and noticing where they crossed the plotted lines of the experiments with different wind velocities, the way the evaporation varied with the wind for any particular $(V-r)$ could be studied. It was found that for all values of $(V-r)$ the evaporation in any particular wind was about the same number of times the evaporation in any particular slower wind or in calm. According to these general views, suppose that when $w=0$ the evaporation varies with changes in $(V-r)$ so as to be equal to $.014 (V-r) + .0012 (V-r)^2$ then with w any other particular value, the evaporation would vary with changes in $(V-r)$ proportionately to $.014 (V-r) + .0012$

* Minutes of the Lit. and Phil. Soc'y of Manchester, Vol. V, Part 2, p. 584.

$(V-r)^2$. As long as the wind is the same, the evaporation is supposed to be a fixed number of times $.014 (V-r) + .0012 (V-r)^2$. The cases where $w = 0$ were selected for use in determining the mathematical expression, because there were more of them than of any other one value of w , and they were liable to less uncertainty. By means of the foregoing, there could be determined from each experiment with its particular value of $(V-r)$ as determined from the observations what the evaporation ought to have been if $(V-r)$ had been 1. Suppose these hypothetical evaporations to be computed for all the experiments, then it may be said that this hypothetical evaporation is $(.014 \times 1 + .0012 \times 1^2) = .0152$ times a quantity fixed according to the wind. From this it follows that this hypothetical evaporation divided by .0152 is the wind factor, which is about $(1 + 0.67 w^{\frac{2}{3}})$, w being the velocity of the wind in miles per hour, as determined by the aid of a diagram made by plotting miles per hour of wind as abscissas and as ordinates the quantity

$$\frac{\text{Evaporation in inches per hour}}{.014 (V-r) + .0012 (V-r)^2}$$

This quantity was obtained by computation for each item in the table (See Table 5), and corresponds to the wind factor required for the formula or $\frac{1}{.0152}$ times the hypothetical evaporation alluded to. By drawing a mean line to represent as nearly as possible all the items plotted, and substituting the mathematical expression as a multiplier of $.014 (V-r) + .0012 (V-r)^2$ the formula for evaporation becomes

$$E = [.014 (V-r) + .0012 (V-r)^2] (1 + 0.67 w^{\frac{2}{3}})$$

As the curves on the diagrams are comparatively slight, an approximate formula can be conveniently obtained by plotting, both on the temperature diagram, Plate LXXII, and on the wind diagram above alluded to, straight lines instead of curves, to fit the experiments. This approximate formula, being an equation of the first degree, becomes much simpler, and will be found sufficiently accurate for most practical purposes, and is as follows:

$$E = .0166 (V-r) \left(1 + \frac{w}{2}\right) ; \text{ or}$$

$$E = \frac{(V-r) \left(1 + \frac{w}{2}\right)}{60}$$

BAROMETER.

It will be noticed that no allowance has been made in the above formula for the barometric pressure.

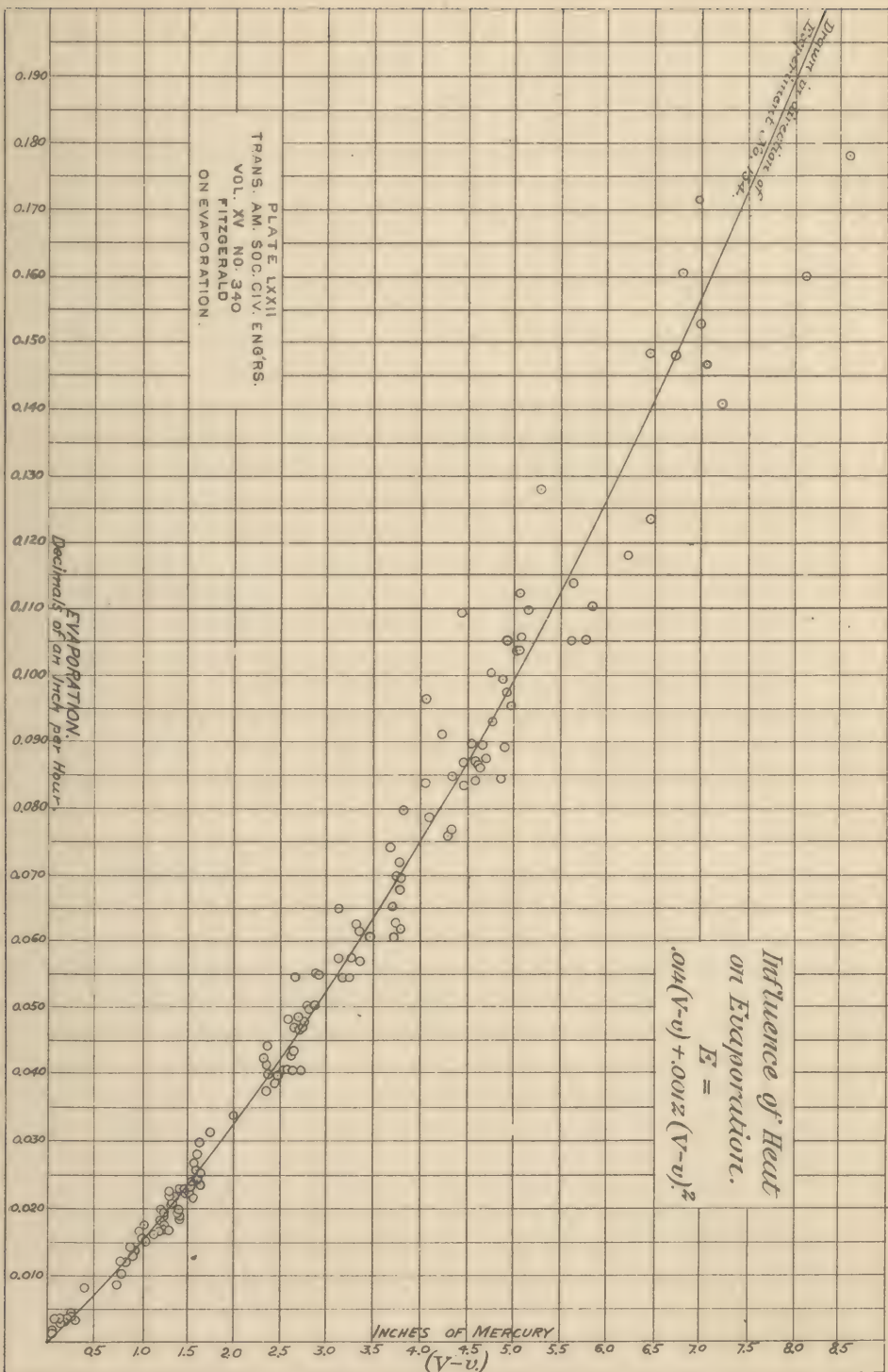
The height of the barometer during each experiment was plotted on the diagram Plate LXXII. but no connection could be traced between the deviations of the experiments from the mean curve and the atmospheric pressure. The writer, after a careful examination of the subject, concluded that ordinary changes in the mercurial column are so slight that they may be safely disregarded as far as their influence on the rate of natural evaporation is concerned.

The same result was reached by Stelling in the Russian experiments. Daniell concluded from many experiments in vacuum that it is not the pressure of the air which affects evaporation, but that the mechanical impediments of the molecules of the air, like the pebbles in the course of a stream, impede the operation, and that the influence of the atmosphere on the rate of evaporation is in inverse proportion to its pressure. The writer has made a series of experiments, under a large bell glass, in vacuo to ascertain the effects on evaporation. It was found necessary to use a condensing apparatus to get the correct force of vapor, on account of the untrustworthy results of the wet bulb thermometer.

The general result of the experiments was to confirm the opinion expressed by Daniell, though sometimes the evaporating dish, which was 3.25 inches in diameter, lost so little of its weight, even after several hours exposure in a vacuum with a large dish of sulphuric acid to absorb the vapor as fast as it formed, that the formula seemed as applicable inside the vacuum as in the open room. On the use of more refined methods of weighing, however, the difference became apparent.

APPLICATION OF THE FORMULA.

We now come naturally to the consideration of the question. How far can a formula be used practically for obtaining the correct evaporation from a water surface by calculation from observations of temperature, wind and humidity? The writer is led to believe, from a large number of applications, that if the data are taken with sufficient accuracy and frequency, there is little doubt but that a very exact result may be reached. It will not do, however, to take the velocity of the wind at some little distance from the evaporating surface, or at any considerable height above it. During the season of 1885 monthly sheets were kept



of all the meteorological data which it was thought could be of any use in throwing light upon the subject of evaporation. These included continuous records of wind velocity. The anemometer, however, was located 30.5 feet above the water. After some investigation it was found that the velocity of the wind was too great, and some experiments were made to establish the relation between the velocity at the surface of the water and at the anemometer.

It was found that the former was about one-third the latter, but that it sometimes varied in an irregular manner.* Table No. 6 exhibits the difference between the actual evaporations as observed and the computed values, based on the supposition that the velocity of the wind exerted at the surface of Tank No. 1 was one-third that observed at the anemometer. The result is such as to give us confidence in the formula when applied to the hourly observations.

It is possible that the computed amount of evaporation for any given hour is nearer the true result than the observed value,† for the reason that there are difficulties in getting an exact measurement by hook gauge where the gauge has to be moved from tank to tank, as was done in the experiments recorded in this paper. The profiles of hourly evaporations (Plate LXXXI.) are plotted from the observed values, and also from those computed by the formula. The good results obtained from the computed evaporations from ice surfaces are shown on pages 613, 614.

EFFECT OF THE SUN.

Some writers having found a difference between the evaporation from a vessel exposed to the rays of the sun and one in the shade, other things being equal, the writer has exposed his evaporimeters in such a way as to test the question. Experiments were made both with the same and with varying depths of water in the pans. Some of these were placed in the sun and others sheltered from its rays. They were carefully weighed every hour, and their temperatures taken every ten minutes. On applying the formula it was found to fit either case equally well. The velocity of

* See Jour. Scottish Met. Socy., Vol. V, pp. 103 and 348, and Nature, Vol. XXVII, pp. 432, 506.

† JUNE 4TH, 1886.—While this paper was passing through the press the author had several striking illustrations of the accuracy of the formula in checking results. On removing the weekly evaporation sheet June 1st, 1886, it was noticed that the amount recorded for the 25th of May was 0.4 inch. As showers had fallen during the night, and the temperature was not high, the writer thought some mistake had been made, but on applying the formula to the meteorological data, he found that the evaporation should have been 0.392 inch, practically the same as recorded by the instrument.

the wind was taken at the level of the pans. The following experiments are selected as fair averages of the series :

No. 1.—14 INCHES DEEP, EXPOSED TO SUN.				No. 2.—1 INCH DEEP, PLACED IN SHADE.		
August 1st, 1885.	Mean Temp. Degrees.	Computed Evaporation. Inches.	Observed Evaporation. Inches.	Mean Temp. Degrees.	Computed Evaporation. Inches.	Observed Evaporation. Inches.
10 to 11 A.M.	82.2	.01	.02	77.7	.009	.008
11 " 12 "	85.6	.02	.02	76.6	.008	.011
12 " 1 P.M.	88.3	.03	.02	76.3	.008	.007
1 " 2 "	89.6	.04	.03	75.3	.009	.011
2 " 3 "	89.9	.04	.04	74.7	.009	.010
3 " 4 "	88.5	.03	.03	73.4	.008	.008
Totals....		.17	.16		.051	.055

Aug. 28th.	No. 1, IN THE SUN.			No. 2, IN THE SHADE.		
10 to 11 A.M.	79.8	.018	.022	62.1	.006	.010
11 " 12 "	85.3	.024	.027	62.1	.006	.008
12 " 1 P.M.	85.4	.026	.026	63.2	.007	.010
1 " 2 "	85.7	.025	.030	64.9	.007	.007
2 " 3 "	83.5	.022	.023	65.8	.008	.012
3 " 4 "	78.2	.020	.022	65.6	.009	.011
4 " 5 "	70.9	.014	.013	64.5	.009	.010
Totals....		.149	.163		.052	.068

INFLUENCE OF DEPTH ON EVAPORATION.

Notwithstanding statements to the contrary, the depth of water has no other influence on evaporation than that due to its effects on the temperature of the surface. A number of experiments, under various conditions, were made in 1885, but they all tended to a uniform result on applying the formula.

The following example is here given, as it combines a variety of data. Two pans, 14 85 inches diameter, were placed side by side in the shade on July 28th. One contained 14 inches of water, the other 1 inch.

Observations were taken from 8 A.M. to 6 P.M., according to the same plan as in previous experiments. Attention is called to the range of temperature.

No. 1.—14 INCHES DEEP, IN SUN.				No. 2.—1 INCH DEEP, IN SHADE.		
July 28th, 1885.	Mean Temp.	Computed Evapora- tion.	Observed Evapora- tion.	Mean Temp.	Computed Evapora- tion.	Observed Evapora- tion.
8 to 9 A.M.	75.5	.008	.010	84.2	.015	.020
9 " 10 "	80.3	.013	.005	89.9	.023	.025
10 " 11 "	84.5	.022	.025	91.4	.032	.036
11 " 12 "	87.0	.029	.030	89.3	.032	.038
12 " 1 P.M.	88.8	.038	.060	87.1	.035	.043
1 " 2 "	89.4	.040	.040	85.8	.033	.036
2 " 3 "	89.7	.043	.030	83.9	.032	.037
3 " 4 "	89.9	.046	.040	82.0	.029	.032
4 " 5 "	88.9	.044	.050	78.5	.023	.023
5 " 6 "	87.3	.033	.020	75.6	.014	.016
Totals....	.....	.316	.310	.....	.268	.306

At 9.30 P.M. observations were taken which showed the deep pan to have lost 12.5 degrees since 6 P.M., while the shallow pan lost 16.1 degrees, leaving the former at 74.8 degrees, and the latter at 59.5 degrees. The observed evaporation during this interval was .050 inch from No. 1, the computed amount being .067 inch, while from No. 2, the observed evaporation was .015 inch, the computed value, .021 inch. The next morning, July 29th, at 7 A.M., the temperature of pan No. 1 was 68.2, and of No. 2, 69.6. Observations of the wet and dry bulb, and of the wind, gave the data for figuring the computed values. The observed evaporation from No. 1 during the night was .090 inch, the computed .070; of No. 2, the observed evaporation was .006 inch, and the computed .018, but the latter difference is fully accounted for by the following facts:

The shallow pan, from an early hour, say 5 A.M., had been gaining rapidly in temperature. Had an intermediate observation been taken, the .018 inch would undoubtedly have been very much reduced. In addition to this, the temperature of the shallow pan at 9.30 P.M. was slightly below the dew point, so that it must have robbed the air of some of its moisture during the night.

OTHER EXPERIMENTS.

The most comprehensive investigation of the law of natural evaporation is included in two articles by Edward Stelling, published among the papers of the St. Petersburg Academy of Sciences.

The first of these articles is entitled "Upon the Dependence of the Evaporation of Water upon its Temperature, and upon the Humidity and Movement of the Air." It was read September 29th, 1881.

The discussion was founded upon experiments made by F. Dohrandt with a Wild evaporimeter and before the improvement made in a floating pan, to which allusion will be made. The observations were taken at Nukuss, from May to October, and comprised notes on the temperature of the water in the sun and in the shade, twelve times a day, at every even numbered hour, with other meteorological data.

The writer is unable, without a more precise knowledge of the methods of making the experiments, to determine as to their accuracy. In this connection it is evident that the form of evaporating dish makes no difference in the results where the laws governing evaporation alone are sought, provided the data are properly collected.

Stelling discusses Soldner's* formula which allows for the barometric pressure, but concludes that the barometer may be neglected. He then analyses Weilenman's† formula which allows for the wind. This formula will not be given, as it is founded on several incorrect assumptions, among them that the temperature of the water corresponds to that of the wet bulb. Stelling's work is superior to all of these, particularly in his method of treating the forces of vapor. His formula, using the notation of this paper, is as follows:

$$E = A \Sigma (V - v) + B \Sigma (V - v) W.$$

This formula is the same in principle as the one adopted by the writer for his working formula. The constants A and B have been replaced by numerical values corresponding to the writer's experiments.

No pains were spared by Stelling in the use of least squares and other laborious mathematical computations to arrive at the truth, yet, after all, he is forced to use constants varying with the different months of the year, and in other ways his formula seems defective as expressing a definite law. In fact Stelling's patient investigations seem to be more those of an accomplished scholar struggling with a somewhat imperfect mass of data, than those of an original experimenter.

The second article, read December 22d, 1881, is entitled "On the Determination of the Absolute Amount of Evaporation from an Open

* Probably $\frac{dv}{dz} = \frac{A(S-s)}{b}$ See Gilbert's *Annalen der Physik*, B. XVII.

† A. Weilenman's "Die Verdunstung des Wassers."

Water Surface." This paper is based on observations made at Pawlowsk Observatory, near St. Petersburg. A floating atmometer was used here in 1878, and certain improvements were made in 1879.

Before the changes, the difference noted between the temperature in the floating instrument and the pool water outside was sometimes as much as 10 degrees C., and amounted in the monthly average to 3 degrees C. The metal bottom came in contact with an air space instead of being washed by the water outside; the latter condition was accomplished by the changes shown by the cut accompanying the article. The temperatures were then brought nearly to an agreement. After an elaborate mathematical analysis, Stelling came to the conclusion, that considering all the uncertainties of the case, the instrument represents almost without correction the evaporation from the surface of the pool. This floating vessel was a shallow pan 357.2 mm. diameter, and having an area therefore of 1 000 cm.². The thermometer was placed near the bottom.

PART II.

DISCUSSION OF OBSERVATIONS ON NATURAL EVAPORATION.

In 1876, the writer began a series of observations on the evaporation from two floating tanks in the center of Chestnut Hill Reservoir. This body of water, which forms the largest distributing reservoir of the City of Boston's water supply, covers an area of 123½ acres, and is in the form of two basins. The larger, or "Bradlee basin," in which the experiments were principally made, covers an area of 85 acres. The depth of water near the center, where the tanks were located, is about 20 feet. The surface is 129 feet above mean sea level. A large raft floated the tanks and it was moored at one end to an anchor around which it could swing freely with the wind. One of the tanks was of wood covered with copper. It was 2 feet square and the water was kept about 1½ feet in depth. The other tank was a simple tin vessel about 1 foot in diameter and 2 feet deep. They were both kept as full as practicable, and immersed so that the level of the water inside and outside was about the same. A record was kept each morning of the heights of the water by means of a hook gauge, an instrument so familiar to engineers that no description is necessary. At the same time the temperatures of the water were taken in the tanks and reservoir, together with a reading of the wet and dry bulbs for humidity of the

air. These observations were maintained until 1882, during the seasons when the water was not covered with ice.

Subsequent observations, taken during every hour of the day and night, led the writer to infer that, owing to the varying temperatures of the water from hour to hour in the tanks as compared with the reservoir, and the varying march of these changes according to the month of the year, little dependence could be placed on the value of the results for application under other conditions unless some relation could be traced by more perfect observations. Accordingly an entirely different apparatus was designed late in the season of 1884 to plot a continuous profile of evaporation upon a sheet of paper. The velocity of the wind and the temperature of the air were also recorded automatically, and the mean humidity secured by readings at 7 A.M., 2 P.M. and 9 P.M.

Plates LXXIII and LXXIV, and the photograph, Plate LXXV, will give a complete idea of the apparatus on the raft, but some description seems necessary. The raft, represented on the right-hand side of Plate LXXIII, was 20 by 40 feet, and so built as to give considerable lateral and longitudinal stiffness. Its surface, which was boarded over, floated about two inches above the water. The front end was left open in a series of breakwaters in which the waves could expend their force. Spray flashboards were added at the extreme outer end. In the center of the raft the tank *A*, 10 feet in diameter and 10 feet deep, was immersed. This tank was made of staves of wood, spaced 1 inch apart, excepting where the hoops were located, so as to give free access for the outer water to the thin copper lining inside. Many holes were bored in the wooden bottom for the same purpose. It was expected that this would keep the water inside at the same, or nearly the same, temperature as that outside, but this was sometimes far from being the case. On one occasion the writer observed a difference of 10 degrees F. A smaller tank, *B*, containing a 16-inch float, was bracketed to one side of the tank, and connected with its center by a pipe which was throttled by a brass plate with a small hole, so that wave motions were not communicated to the float. The recording apparatus was on the same bracket with the float chamber, and immediately over it. A light cover of tin protected it from the weather.

As finally adjusted, the weight of a man stepping suddenly upon the raft carried the pencil 0.25 inch from the profile, and on his stepping off, the pencil returned to its former position. These perpendicular marks

Apparatus for recording Evaporation.

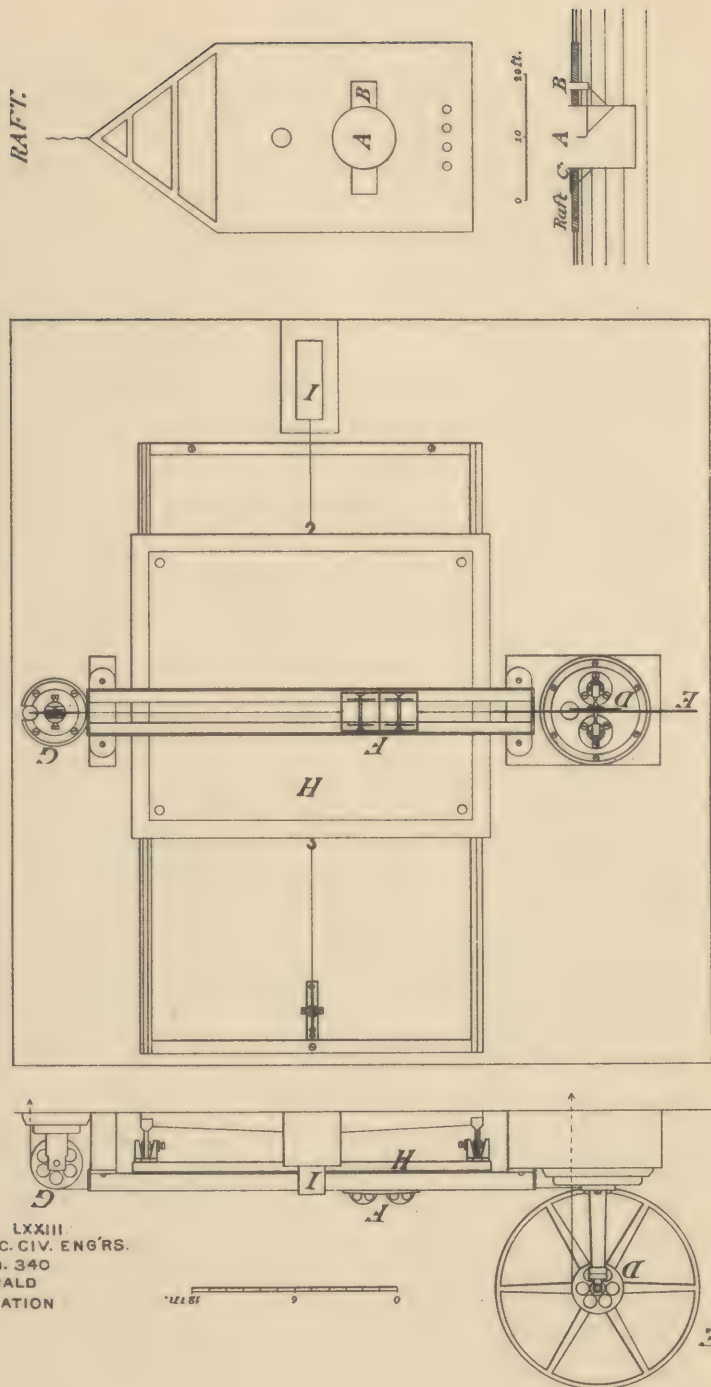


PLATE LXXIII.
TRANS. AM. SOC. CIV. ENGRS.
VOL. XV NO. 340
FITZGERALD
ON EVAPORATION

PLATE LXIV.
TRANS. AM. SOC. CIV. ENGRS.
VOL. XV NO. 340.
FITZGERALD
ON EVAPORATION





TRANS. AM. SOC. CIV. ENG'RS.
VOL. XV, No. 340.

PLATE LXXV.

FITZGERALD
ON EVAPORATION.

on the diagram could be readily distinguished from the profile of evaporation, and in no way interfered with the record, on the contrary, they served to check any unlawful visits to the raft.

THE RECORDING APPARATUS.

A plan and side elevation of the recording apparatus are given on Plate LXXIII. The wheel *D*, 3 inches in diameter, was connected directly with the float by a fine wire. The large wheel *E*, 1 foot in diameter, was rigidly connected with *D*, and communicated the movements of the float, magnified four times, to the small truck *F*, which was counterweighted at the end of the wire passing over the wheel *G*. The truck, running in a V-shaped grooved track, carried a pen which left its record on the diagram spread on the drawing board *H*. This board was pulled over a track at right angles with the movements of the truck by a clock movement *I*. Every inch of vertical movement of the float made 4 inches of movement on the diagram, so that hundredths of an inch could easily be read. The wheels were all mounted on agate bearings, and were nicely balanced. The whole friction of the apparatus was less than 0.01 of an inch, as read on the diagram. The details of this delicate piece of machinery are given on Plate LXXIV, and one of the diagrams covering a week's time, photographed on a reduced scale, is given on Plate LXXVI.

By means of these continuous profiles, all the changes taking place on the surface of the large tank were accurately recorded where they could be examined at leisure, and in comparison with the meteorological data. The tank was not only a self-recording evaporimeter, but was also a self-recording rain gauge. An independent rain gauge of excellent pattern was, however, kept on the raft, and also others on the land adjoining the reservoir. It became evident from these records that evaporation may amount to a measurable quantity, even during a rain storm. Indeed, under certain unusual conditions, the writer has observed clouds of vapor in a visible form rising from pools of water while rain was falling. Maximum and minimum recording thermometers were placed both in the tank and the water of the reservoir. These were attached to tin floats, 2 inches in diameter and 6 feet deep, so that the bulbs were just beneath the surface of the water. These glasses were read and set daily. Six smaller tanks of various forms and depths were also kept on the raft from time to time, and a record of

their temperatures taken at about the hours of maximum and minimum temperatures, viz., 7 A.M. and 3 P.M. Their position on the raft is designated by the small circles.*

TEMPERATURES.

In order to insure accuracy in the temperature comparisons, considerable study was given to this branch of the subject. It was finally decided to use for all hourly observations a thermometer made by Baudin, Paris, and for all other observations nine thermometers by Alvergnyat, Paris, which had been made some time previously. These were all tested for different points in the scale, through the courtesy of Prof. Holman, at the Massachusetts Institute of Technology, and their corrections tabulated. The Baudin instrument was graduated to 0.2 degrees C., and could be easily read to 0.1 degree. The maximum and minimum thermometers were made by Green, of New York. Their errors were tabulated. All of the centigrade readings have been converted into Fahrenheit.†

OTHER INSTRUMENTS.

An electrical recording anemometer was kept on the shore of the reservoir. The cups were at grade 154.5, or 30.5 feet above the water. The velocity of the wind where the anemometer was placed was found to represent generally three times that at the surface of the water (see page 591). In a standard shelter, and excellently exposed, were a Green psychrometer, a Richard Frères thermograph, and maximum and minimum thermometers. Humidity observations founded on readings of the dry and wet bulbs are to be accepted with considerable caution. From many comparative readings made for the purpose, the writer is led to believe that there is hardly any instrument in common use which is liable to so many errors. The formulas on which the tables are based are founded on assumptions which are more or less correct, but the principal sources

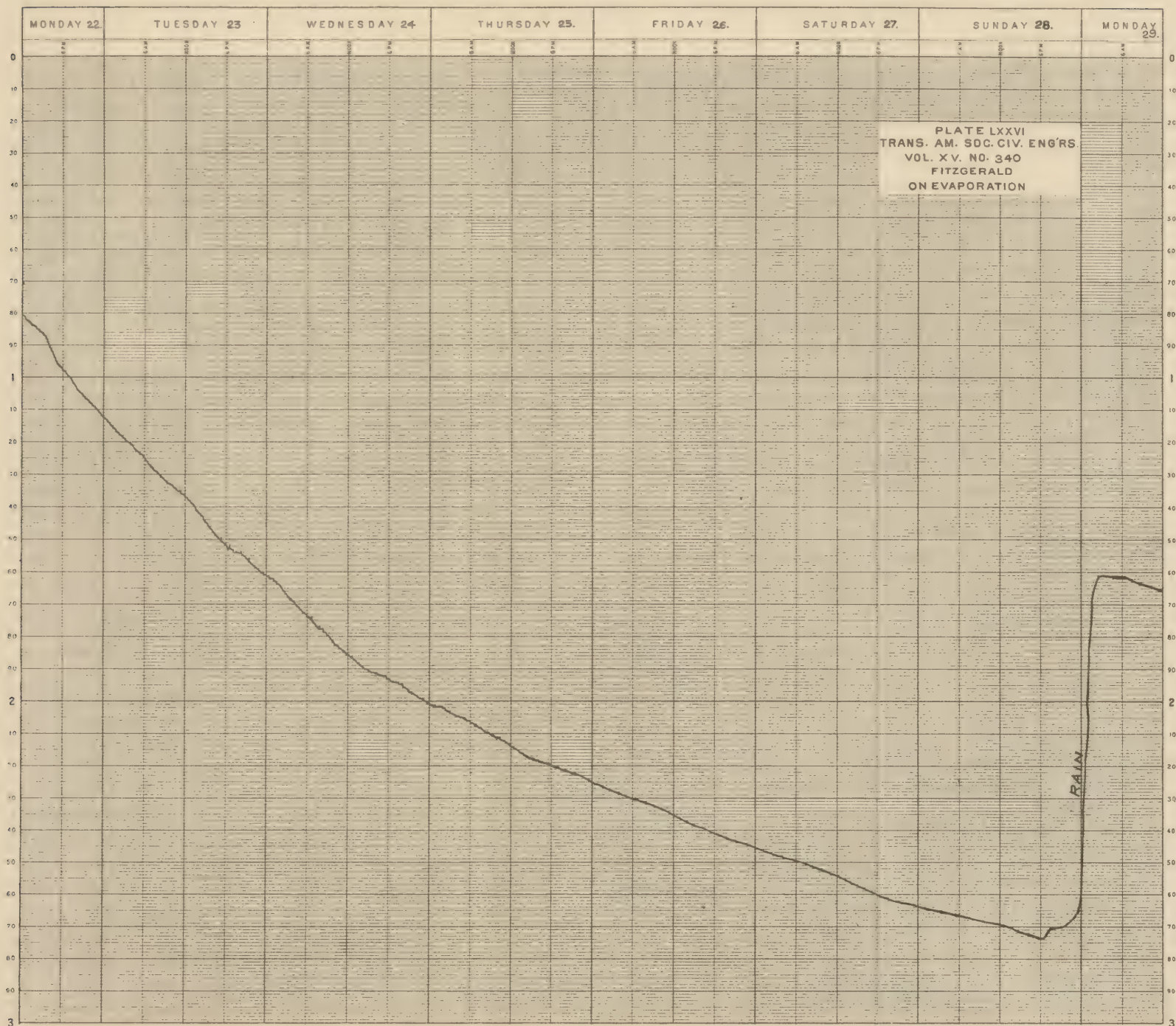
* The following are the dimensions of all the tanks :

Tank No. 1,	copper,	10 feet	diameter	10 feet	deep.	
" "	2, tin,	1 "	"	8 "	"	"
" "	3, "	1 "	"	2 "	"	"
" "	4, copper,	1 "	"	2 "	"	"
" "	5, tin,	1 "	"	6 inches	deep.	Painted white.
" "	6, "	1 "	"	6 "	"	" dark green.
" "	7, "	3 "	"	6 "	"	"

† The folly of the Fahrenheit scale has been recently shown in a paper read before this Society by Mr. Fred. Brooks, M. Am. Soc. C. E. (No. 333. May, 1886.)

DIAGRAM OF EVAPORATION FOR WEEK ENDING JUNE 29TH 1885.

By Continuous Recording Apparatus designed by Desmond Fitzgerald to determine evaporation from a water surface. Experiment conducted at Chestnut Hill Reservoir Boston Water Works.



of error arise from differences of exposure, lack of ventilation and the use of round bulb glasses. Where the air is not moving across the wet bulb at a proper speed, a fan should be used. Below freezing the observations are practically worthless. There is little doubt that a condensing hygrometer of any good form is far more trustworthy. Such an instrument will give the dew point at once from which the force of vapor and the relative humidity, if it is desired, may be easily computed. During a certain portion of the summer of 1885, two sets of maximum and minimum thermometers were kept alternately in Tank No. 1 and in the reservoir. There are numerous errors to which these instruments are liable, and the duplicate set acted as a check. In addition, readings were usually taken at about the hours of maximum and minimum temperature, viz., 7 A.M. and 3 P.M., with the Baudin standard. The readings of all these instruments are compared in Table No. 1.

Finally, all the meteorological data were collected on monthly sheets, from which information of different kinds could be obtained as needed. From these sheets Table No. 2 was collated. This table shows only the mean daily temperature of the surfaces of the reservoir and of the several tanks, and the daily evaporation from the tanks.

It must be borne in mind that these means do not give us an idea of the range of temperature during the days given. A small body of water may give exactly the same mean as a larger one, and yet pass through a very different scale in the 24 hours. To speak accurately, evaporation does not depend upon the means, but upon the conditions from moment to moment.

HOURLY OBSERVATIONS.

To determine how far the changes between small fractions of a day affected the means, a series of hourly observations was made on at least one day in every month. These are embodied in Table No. 3, and will be found to possess particular value. As will be noticed, in July a three days' period of continuous observations was secured. The weather was fine during nearly the whole time. The summer nights are rarely accompanied by much wind, and special arrangements can be easily made for taking the temperatures to 0.1 degree as readily as by day. In observing water temperatures it was made a uniform rule to hold the glass as nearly horizontal as convenient with the long bulbs of the

French makers just beneath and as near the surface as possible. When the sun was shining the bulb was shaded with the hand, though this was found to make no material difference in the readings.

The profiles, Plates LXXVII and LXXVIII, exhibit graphically the temperature changes at the surfaces of the reservoir and tanks at all hours of the day and night for short periods at different times.

In the early part of the summer the large tank was sometimes so much hotter than the reservoir, that the writer believed important corrections would have to be made for temperature, but as the season advanced these differences grew less and less, and in the autumn the reservoir became warmer than the tank as often as otherwise.

While these daily and hourly data were accumulating, the experiments already described were made to determine the exact laws governing evaporation. The general result was to lead to a close scrutiny of the temperatures of the evaporating surfaces, of the force of vapor in the air, and of the velocity of the wind, which were found to be the three important factors.

SOME RESULTS.

It became evident, from an inspection of the continuous diagrams, that the maximum evaporations are not recorded on the hottest days in the year. A high temperature of the air means commonly a considerable force of vapor present in the air, so that $(V-r)$ is not as great on such a day as when the air is cool and of low vapor carrying capacity. When a body of water is heated to a high temperature, and the air becomes cooler, the temperature of the water does not change much, and V is still large, while r will be much reduced, so that $(V-r)$ becomes larger and evaporation proceeds more rapidly. Thus on a cold day, preceded by warm weather, we may look for the maximum evaporation. Such we find, by many observations, to be the case. On June 23d, 1885,* the greatest evaporation that the writer has ever recorded occurred at Chestnut Hill Reservoir, viz.: 0.57 inch from Tank No. 1, 0.64 inch from Tank No. 2, and 0.58 inch from Tank No. 3. The mean temperature of the water in the reservoir for this day was 70.7 degrees; in Tank No. 1, 69.8, in Tank No. 2, 70.8; and in Tank No. 3, 69.9 degrees. Judging by the comparative data, the evaporation from the

*A day in the Chestnut Hill Reservoir experiments was always taken from 5 P.M. of the preceding day to 5 P.M. of the date given, and is so understood throughout this paper.

reservoir must have been nearer 0.64 inch than 0.57 inch. The mean temperature of the air was 60.2 degrees, about 10 degrees less than on the preceding days. The force of vapor in the air, largely owing to its low temperature, was only 0.313 inch. The velocity of the wind averaged 12.3 miles per hour 30 feet above the water, a combination of circumstances that favored a very large evaporation. The results for the whole week ending June 29th were so remarkable, that the diagram from the recording apparatus has been selected from the other sheets for reproduction in this paper. (See Plate LXXVI.) It is doubtful if the evaporation from a natural water surface in a single day in Massachusetts will ever much exceed this amount. The maximum daily evaporation in Arles, France, from M. Salle's experiments (see page 622) was 0.56 inch on July 31st, 1878.

The evaporation for the six days after noon of the 22d above alluded to was so extraordinary, that its effects on vegetation were noticed throughout the surrounding country. Fortunately, hourly observations were secured for 48 continuous hours during this period, which will be found in Table No. 3.

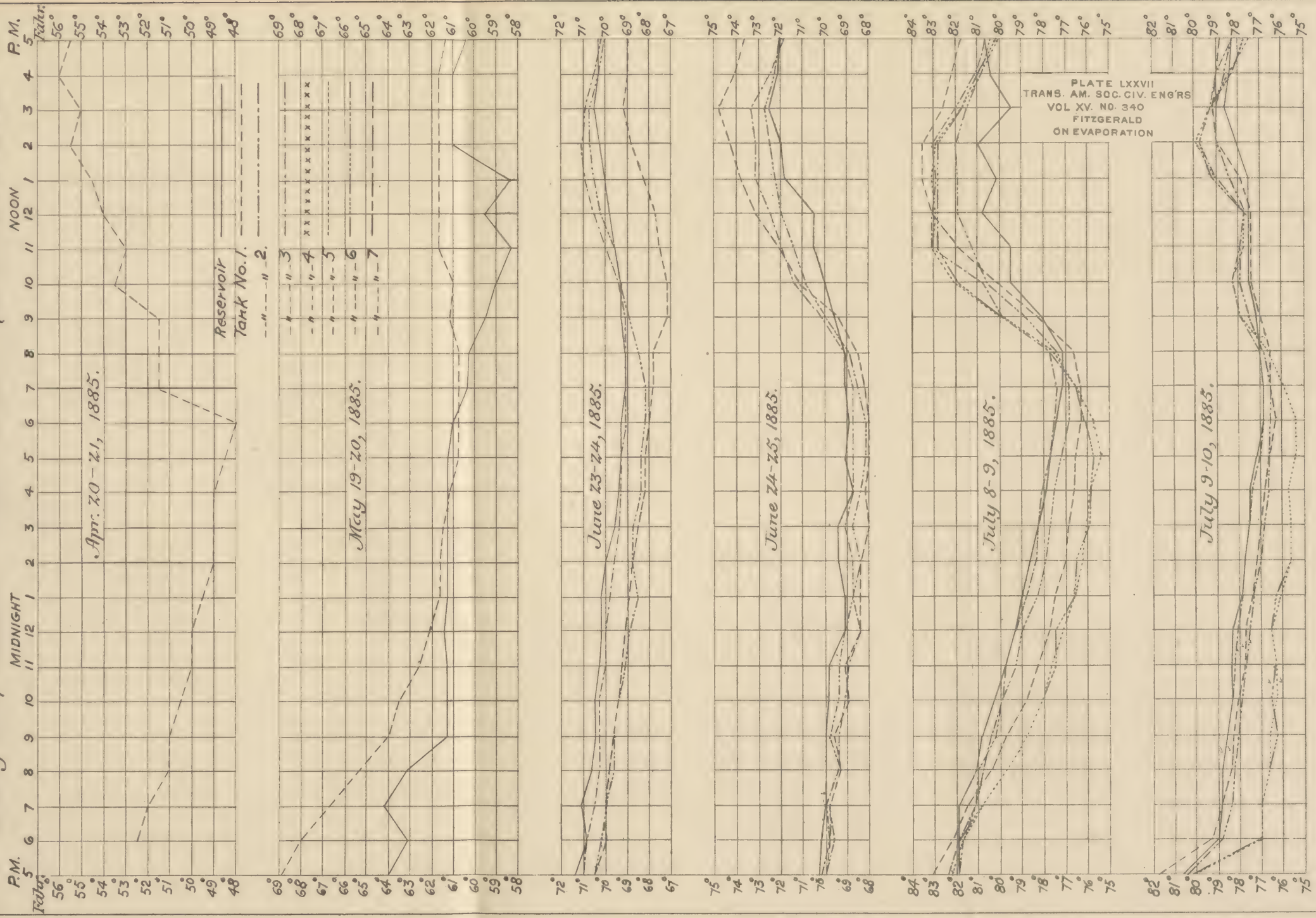
On December 19th, 1885, the writer was passing the reservoir, when his attention was called to clouds of vapor rising from the water. A strong wind was blowing these clouds across the road, and it was observed that evaporation was proceeding at such a rate as to obscure more than half of the sheet of water. The temperature of the air was 20 degrees below the freezing point, viz.: 12 degrees F. The temperature of the water, both at the surface and at a depth of 10 feet, had been 38 degrees for some time owing to warm weather. At the time of the observation it stood at 37 degrees. The vapor in the air was = 0.030 inch. Here we have also favorable conditions for the rapid formation of vapor, which quickly filled the cold air with more than it could carry in an invisible form. The wind was blowing at the surface of the water at a rate of at least 4 miles per hour by estimation.

The writer is satisfied that the rate of evaporation under the above conditions must have been about 0.23 inch per day. (See formula, page 589.) Undoubtedly this is a very unusual state of things, but when evaporation during the winter months is so often placed at 0, this case is worth remembering.

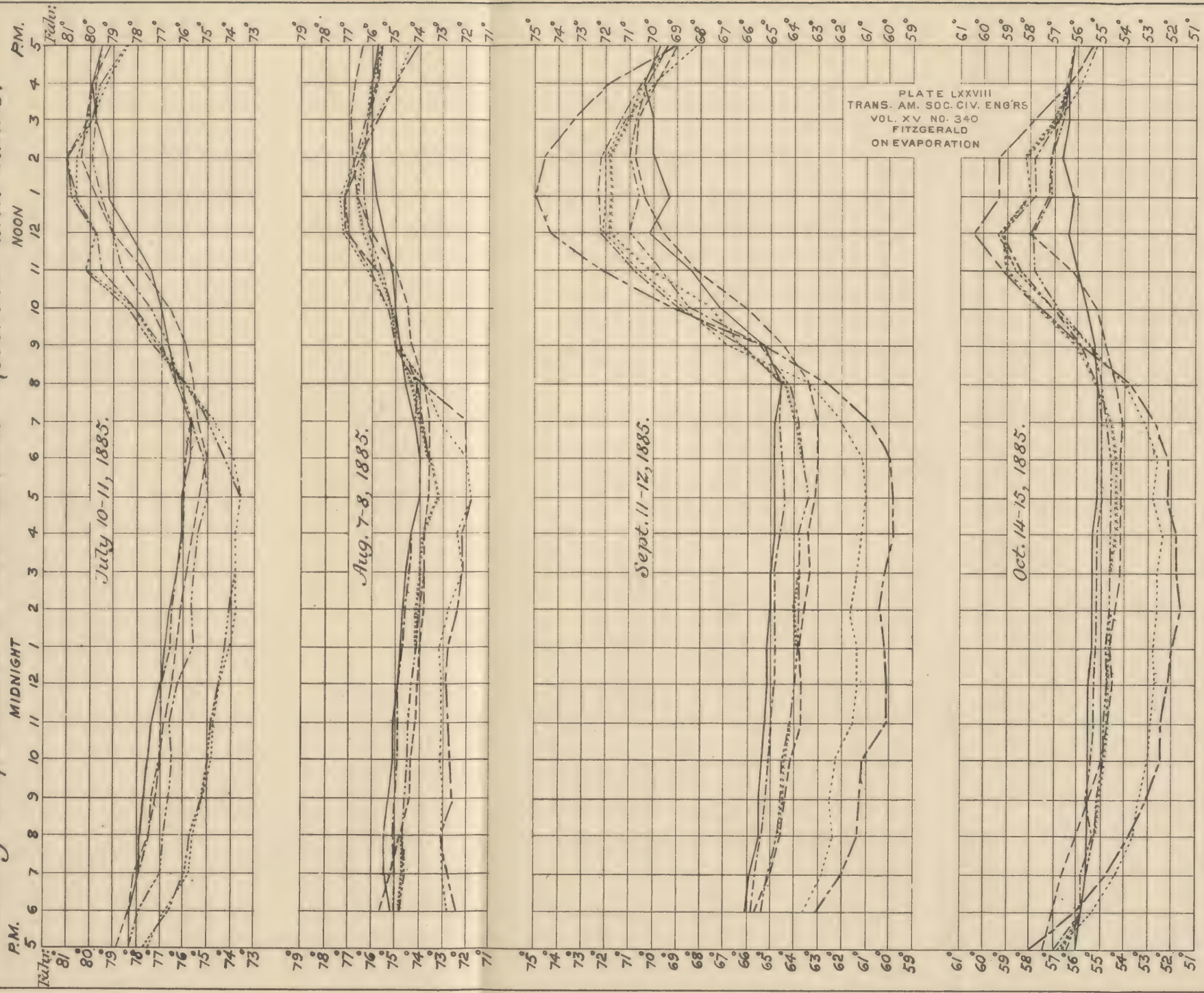
Another important result of the hourly observations and of the re-

corded diagrams, was the development of the fact that the evaporation from a large water surface is nearly alike during the day and night. Such is undoubtedly the fact, and must be apparent after a due consideration of the results in the tables and a study of the theoretical side of the question. During the principal part of the season of 1885, observations were taken of the tanks night and morning in such a way as to give full information on this point. A glance at the profiles of hourly temperatures, Plates LXXVII and LXXVIII, will show that there is not very much difference in mean water temperatures between the day and night hours. It takes the greater part of the day for the water to regain the heat which it loses during the night. In Table No. 3 the evaporation of the night has been separated from the day for the days when hourly observations were taken, and when little doubt could be thrown on the mean temperatures of the water. In comparing the day with the night evaporations it must be borne in mind that the velocity of the wind is generally greater in the middle of the day than at other times, and so has its influence on the amount of evaporation, but on days when there is little wind, or wind equally distributed throughout the 24 hours, the evaporation is practically the same day and night. Of course, the smaller the amount of water exposed the less will the rule apply, for the more nearly will its temperature follow the temperature of the air. This is the reason for the great errors in ordinary experiments on evaporation made from small atmometers above ground, whose sides are fully exposed to the air and sun. With such instruments the evaporation for the day will be very great, and that during the night correspondingly small, in no way following the evaporation from a large pond of water. In shallow pans, immersed in the body of a stream or pond of water, as was the case with Tanks Nos. 5, 6 and 7, which were only 6 inches deep, the total evaporation in a long period does not differ very much from that from a large body of water, for the reason that the differences generally happen to balance or may balance in a season, some months showing larger and others smaller results than the deeper body of water. It has been found by the writer that the evaporation from a considerable body of water may be greater on some particular days, even during midsummer, than from a shallow pool. When the air is cooling rapidly, its influence will be felt very much sooner in the latter than in the former case. Again, it is possible that on an extremely hot day, the loss from a large body of water may be greater than from a

Hourly Temperatures of Water Surfaces—Reservoir and Tanks.



Hourly Temperatures of Water Surfaces - Reservoir and Tanks.



shallow pool, from the fact, which the writer has several times observed, that the maximum temperature of the reservoir may not occur until very late in the afternoon, say 6 p.m., long after the shallow tank had begun to part with heat.

The question is often asked, "What is the highest temperature that the surface of a reservoir ever attains?" At 5 p.m. on July 18th, 1885, the temperature of the water in Chestnut Hill Reservoir was 82.2 degrees at the surface, and practically the same to a depth of 5 feet. At 7 feet it was 80.5 degrees; at 8 feet, 79.0 degrees; at 9 feet, 77.5 degrees; at 10 feet, 76.0. At 7 a.m. the same day, the surface was 78.4 degrees. On September 10th, 1884, the writer found the temperature of the surface of the same reservoir at 86.0 degrees, taken with a Green thermometer, stem graduated, whose error was not known, but probably not far wrong. This was during a period of extraordinary heat. The temperature of the water in a copper rain gauge, covered, was found to be 116 degrees at the same time. On account of the interest which they possess as illustrating some of the above remarks, the hourly temperatures of the reservoir and of all the tanks is here given for July 18th, 1885, from 7 a.m. to 6 p.m. It will be noticed that the shallow pans, Nos. 5 and 6, attained their maximum at 1 p.m., viz., 82.8 degrees, and that at 6 p.m., when the reservoir had lost but 0.5 degree, they had lost 2.9 degrees.

JULY 18TH, 1885.

	7	8	9	10	11	12	1	2	3	4	5	6
	A.M.	A.M.	A.M.	A.M.	A.M.	M.	P.M.	P.M.	P.M.	P.M.	P.M.	P.M.
Reservoir.....	78.4	79.5	79.3	79.9	80.8	80.6	81.1	81.3	81.7	81.9	82.2	81.7
No. 1.....	77.4	78.8	79.7	80.2	81.1	82.2	82.9	83.1	83.1	82.8	82.4	81.9
" 2.....	78.4	79.9	80.6	80.8	81.9	81.9	82.6	82.6	82.4	81.9	81.5	81.3
" 3.....	78.1	79.3	80.1	80.2	81.1	81.5	81.6	81.9	82.0	81.9	81.5	81.3
" 5.....	78.3	80.1	80.8	81.1	82.2	82.2	82.8	82.6	82.4	81.3	81.5	79.9
" 6.....	78.1	80.2	80.8	81.0	82.2	82.4	82.8	82.6	82.4	81.5	81.3	79.9

In the course of the whole season, Tank No. 1 gave about 8 per cent. less evaporation than Tank No. 3. This occurred repeatedly when the temperatures were the same, and it was also the case when the temperatures were taken hourly, when it would seem that the mean temperatures could not be far from correct. The writer is unable to say certainly to

what the difference was due, but is inclined to the opinion that capillary attraction on the inside of the small tanks increased the evaporating area.

MONTHLY RESULTS.

We now return to the consideration of the monthly evaporations observed at Chestnut Hill Reservoir during six years between 1876 and 1886, and to the corrections, if any, to be applied to the wooden box or tin vessel. These results were published in the Reports of the Boston Water Board from year to year, but a careful review of the original notes, and a new analysis in the light of greater experience, has led to the detection of certain errors, mostly small in amount, which will account for the difference between the values now assumed for certain months and those already published. The labor of this analysis was very great, as every observation during the whole period had to be critically examined.

The evaporations from the wooden box and from the 10-foot tank were finally adopted as representing the evaporation from the reservoir without any further corrections for temperature.

The reasons for this were numerous, but principally as follows: The evaporation from the wooden box was from 7 to 30 per cent. less than that from the tin vessel, and at Beacon Hill Reservoir, which will be referred to immediately, was found to correspond very closely with the measured evaporation from the reservoir. The writer concluded from his experiments in 1885, that although the mean temperatures were about the same, the surface of the reservoir was generally cooler during the middle of the day, when there was most wind, than Tank No. 1, and notably less than the smaller tanks. As far as temperature was concerned, therefore, a slight correction in the way of subtraction should be made from the large tank, but it is undoubtedly true that the reservoir surface had a better exposure to the wind, which would have required a correction in the opposite direction.

The table at head of the next page will show the mean monthly temperatures in Tank No. 1, and in the reservoir for 1885.

During the months of August and September, the Lawrence basin was shut off from the city's supply, for the purpose of measuring the actual evaporation from its surface while the other experiments were in progress. This basin has an area of 37½ acres. On the days when there was little difference in head between the two basins, the measured evaporations agreed very well with those from Tank No. 1. From

	NO. OF DAYS.	RESERVOIR. Degrees F.	TANK No. 1. Degrees F.
May.....	13	61.2	62.8
June.....	29	69.5	70.4
July.....	31	77.3	77.2
August.....	31	74.4	74.4
September.....	30	66.0	66.0
October.....	31	57.0	57.0

September 1st to 22d, when there was little difference of head, the evaporation from the reservoir was found to be 3.83 inches, and from the tank, 3.87 inches.

It must be remembered, however, that as already mentioned, a true idea of evaporation cannot be arrived at by an examination of means, but the writer believes the means of the wooden box and reservoir temperatures, considered through all the varying seasons, to represent, when examined in detail, a pretty fair correspondence.

It is of course doubtful if an exact result can ever be reached in the case of a large reservoir of water, certainly never until it can be proved to be water-tight both at sides and bottom, and experimented on as a whole, and even then the result would only apply to that particular sheet of water. Another, though but a short distance from it, would certainly vary somewhat from difference of situation and exposure to the air, sun and wind.

MEANS.

	Box.							Tin Vessel.						
	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	May.	June.	July.	Aug.	Sep.	Oct.	Nov.
1876.....	5.44	7.50	6.21	3.48	3.12	0.66	....	5.71	8.82	7.94	5.23	4.57	1.13	....
1877*.....	4.05	5.68	4.82	4.40	4.08	2.51	....	4.35	6.45	6.02	5.55	5.83	3.59	....
1878.....	4.14	5.26	6.04	4.33	4.04	3.52	....	4.86	5.84	8.19	5.18	5.40	4.66	1.72
1879.....	5.89	5.32	6.41	5.23	3.80	2.99	....	6.28	6.36	7.75	6.72	5.33	4.36	1.75
1880.....	5.22	6.46	5.82	5.34	4.04	2.79	2.60	5.21	7.79	7.24	6.78	5.64	4.04	2.50
1885.....	3.77	7.01	7.09	7.41	5.13	2.79	....	3.97	7.86	7.99	6.87	5.64	3.39	....
Means.....	4.61	5.86	6.28	5.49	4.09	2.95	1.63	4.93	6.67	7.67	6.50	5.51	4.10	1.77

* Supplied by calculation from the tin vessel observations.

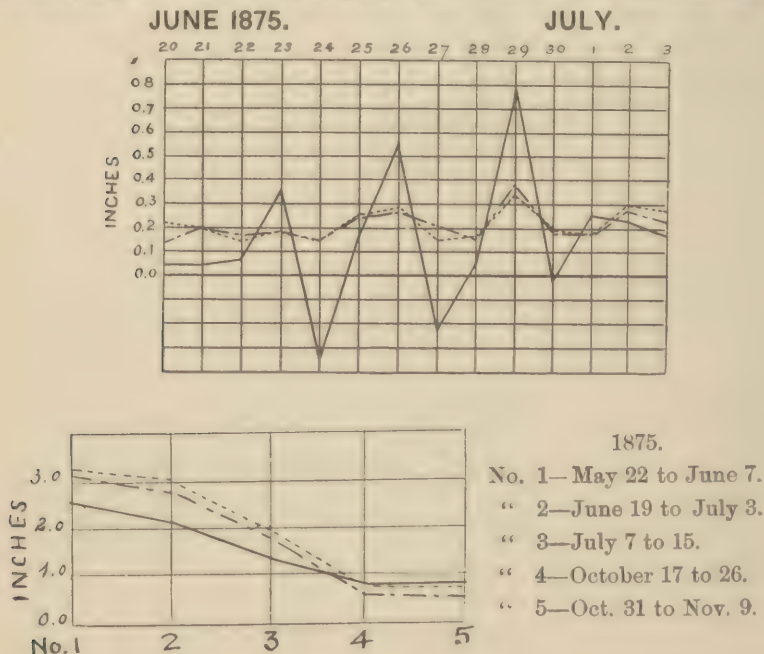
BEACON HILL RESERVOIR.

On May, 1874, evaporation experiments were started at this reservoir under the direction of the City Engineer, Mr. J. P. Davis, M. Am. Soc. C. E. The Beacon Hill Reservoir was a stone structure built on arches and raised above the surface of the ground. It was in the center of the city, surrounded by buildings which were generally higher than the reservoir surface. It was somewhat less than an acre in area and about 11 feet deep. The evaporation was measured in three ways: 1st. From the reservoir surface; 2d. From a wooden floating-box; and 3d. From a tin vessel.

All of the original notes were placed in the hands of the writer, and have been submitted to a careful examination.

The values as finally adopted for the records from this reservoir differ slightly from those published in the Water Board Reports, but are believed to be more correct. There were innumerable difficulties in the way of arriving at the true evaporation from this reservoir.

The notes show such irregularities as to warrant the rejection of a large portion of them. Every attempt was made to ascertain the cause of the daily fluctuations in the gauge-box. The head in the reservoir



being always considerably greater than that in the mains outside, precluded the idea of a leak through the gates as explaining the difficulty. The reservoir was filled by a small pipe connecting with the high service. As the structure has since been torn down, no opportunity for further investigation has presented itself.

On the whole, the writer is inclined to believe the wind to be the cause of the trouble, as he has frequently noticed the water to be piled up on one side of a reservoir, even in a moderate wind, and sufficiently so to affect the readings in a gauge-box. A fair sample of the daily evaporation record from the reservoir surface is plotted on the preceding profile, and compared with the evaporation from the floating evaporimeters, and in the second profile the means for several dry periods are plotted, which show a better result. Accordingly, the monthly means from the reservoir have been admitted, except in instances where they were obviously wrong.

Taking first the records of the wooden box and tin vessel which were begun in 1875, we have the following figures for the monthly evaporation in inches.

Box.								FROM THE RESERVOIR.		
	May.	June.	July.	Aug.	Sep.	Oct.	Nov.			
1875.....	4.72	5.23	6.54	5.00	4.94	2.55	1.47	January.....	0.65	1 year.
1876.....	4.79	5.15	7.33	.....	3.56	2.83	.....	February.....	0.68	1 "
1877.....	3.66	5.53	5.35	4.56	4.29	.....	.....	March.....	2.30	1 "
1878.....	3.65	4.58	6.08	4.31	3.58	2.49	.....	April.....	2.45	1 "
Mean.....	4.20	5.12	6.32	4.62	4.09	2.62	1.47	May.....	3.58	6 years.
Tin.								June.....	4.23	5 "
	May.	June.	July.	Aug.	Sep.	Oct.	Nov.	July.....	6.34	5 "
1875.....	4.63	5.51	7.15	5.72	5.82	2.93	1.75	August.....	4.85	4 "
1876.....	4.48	5.29	7.88	.....	4.80	3.75	.....	September.....	4.34	5 "
1877.....	3.96	6.05	5.98	5.29	5.57	.....	.....	October.....	2.77	4 "
1878.....	4.07	4.88	7.03	4.63	4.31	3.24	.....	November.....	1.80	3 "
Mean.....	4.28	5.43	7.01	5.21	5.12	3.31	1.75	December.....	0.79	3 "

DRY PERIODS.

The following tables show the evaporations both at Beacon Hill Reservoir and Chestnut Hill Reservoir during dry periods, when the observations were undisturbed by rain.

BEACON HILL RESERVOIR.

No.	1875.	No. of Days.	Res.	Box.	Tin.
1	May 22, June 7.....	16	2.63	3.13	3.33
2	June 19, July 3.....	14	2.15	2.91	3.04
3	July 7-15.....	8	1.42	1.79	1.96
4	October 17-26.....	9	0.73	0.63	0.78
5	October 31, November 9.....	9	0.94	0.64	0.91

BEACON HILL RESERVOIR.

CHESTNUT HILL RES.

1877.	No. of Days.	Res.	Box.	Tin.	Tin.
May 26, June 5.....	10	1.30	1.86	2.02	2.16
June 9-21.....	12	1.94	2.27	2.58	2.47
July 30, August 8.....	9	1.63	1.58	1.83	2.07
August 20-25.....	5	0.70	0.84	1.00	0.94
September 3-19.....	16	3.03	2.94	3.18	2.80
September 24-October 3....	9	1.07	1.11	1.49	1.26

BEACON HILL RESERVOIR.

CHESTNUT HILL RESERVOIR.

1878.	No. of Days.	Res.	Box.	Tin.	Box.	Tin.
May 17-30.....	13	1.49	1.79	1.93	2.10	2.09
June 1-8.....	7	1.20	1.33	1.42	1.46	1.59
June 24, July 9.....	15	2.82	3.34	3.87	3.69	4.04
July 12-20.....	8	1.68	1.68	2.04	1.63	1.97
August 12-19.....	7	1.04	1.03	1.17	1.06	1.17
" 26-31.....	5	0.64	0.79	0.97	0.80	1.05
September 14-26.....	12	2.08	1.96	2.42	1.85	2.50
" 30, October 9.....	9	0.74	0.99	1.31	1.07	1.49
October 16-23.....	7	0.75	0.63	0.81	0.74	0.95

BEACON HILL RESERVOIR.

1879.	No. of Days.	Res.	Pan.
May 21-31.....	10	2.13	2.63

CHESTNUT HILL RESERVOIR.—DRY PERIODS.

1885.	No. of Days.	RES. Mean Temp.	TANK No. 1.		TANK No. 2.		TANK No. 3.		TANK No. 4.		TANK No. 5.		TANK No. 6.		TANK No. 7.	
			Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.
June 9-28.....	20	71.0	72.0	5.32	....	....	71.1	6.03	....	....	....	....	....	....	....	....
" 13-28.....	16	72.3	73.2	4.17	72.6	4.73	72.4	4.84	....	....	....	....	....	....	....	....
July 15-28.....	14	79.2	79.3	3.48	79.5	3.96	79.1	4.02	....	....	78.9	3.94	78.9	3.87	....	....
Aug. 5-21.....	17	75.7	75.9	4.59	76.3	4.26	75.6	4.17	75.6	4.05	75.3	4.19	....	....	....	....
" 7-21.....	15	75.5	75.7	3.94	76.1	3.69	75.5	3.59	75.4	3.50	75.1	3.62	....	....	75.6	3.43
Sep. 11-22.....	12	66.8	66.9	1.99	67.4	2.36	66.4	2.28	66.9	2.30	65.8	2.16	....	....	66.3	2.03
" 25-Oct. 1...	7	63.1	63.2	0.76	63.8	1.02	63.0	1.01	63.4	0.99	62.3	0.90	....	....	63.2	0.91

EVAPORATION IN WINTER.

The evaporation in the winter after the middle of December is generally from a surface of snow or ice. The difficulties of measuring the loss of vapor in these months has led to too low an estimate of the result. The evaporation for three or four months of the year is commonly placed at zero.

During the winter of 1878-79, the writer designed an apparatus for measuring the evaporation from snow as it commonly rests on the earth or ice. It consisted of a metal-lined box, having an area of 1 732 square inches. This was filled to a depth of 9 inches with a mixture of sand, clay, loam, etc., and was sunk into a framework in the ground, within which it could be raised or lowered. A light form of track some distance over the box carried a truck, which was moved forward over the box when it was to be weighed. The box was kept filled with snow to its top as far as practicable, and the losses by evaporation were determined day and night by hanging a large scale beam on the truck and screwing up the box and scale through the center of the truck. One ounce in weight represented 0.001 of an inch in depth of water. The scale was sufficiently delicate in adjustment to obtain the true weight within five ounces.

Whatever filtered through the earth was caught in a pan and weighed separately. After the earth once became frozen, however, it was watertight, and nothing went through it until the spring thaw, though several inches of water at times stood on the surface. The general result gave 0.02 inches per day for the winter average.

Many comparative experiments have been made from time to time at Chestnut Hill Reservoir between snow and ice evaporation, and it has been found that the evaporation from ice is nearly twice as rapid as from snow, that is to say in two atmometers, 14.85 inches in diameter, placed side by side and filled with snow and ice, both resting on scales, so that the loss of 1 ounce = 0.01 inch of water, the ice will lose twice as much weight as the snow in the same time.

From February 19th to February 25th, 1885, observations were taken on the loss from a cake of ice properly exposed to the air, and it was found to lose at the rate of 0.06 inch per day. On March 11th the same experiment was repeated and minutes kept, sometimes every hour, of the loss by weight. The records were maintained until March 27th.

This period gave an average of 0.04 inch per day. On February 24th, 1886, the writer found evaporation from an ice surface, with the wind at 12 miles an hour, proceeding at the rate of 0.2 inch per day. It is not probable that the above represents the exact evaporation from a large ice surface any more than the evaporation from a small evaporometer represents the true results from a large body of water. In order to get some comparative data on which to form an idea of the proper corrections, and whether the evaporations from ice followed the same laws as that from water, numerous experiments of a theoretical nature were made, and the general result was such as to lead the writer to believe that this is really the case as stated by Dalton.* Experiments, however, which fail to secure the exact temperature of the surface of the ice will be deficient, as were Dalton's, for the ice does not follow the temperature of the air any more than the water does. Furthermore, the temperature of the ice in the reservoir is very often entirely different from that in an experiment in the air some little distance above its surface, and without a large mass of water under it. In all the experiments made by the writer on the evaporation from ice, the following general methods have been adhered to, in order to secure accuracy of results. Cakes of ice have been uniformly trimmed to a diameter of 14.85 inches, and then fitted into the same pans illustrated in Plate LXX. The surfaces have then been planed to a perfect level, and exactly even with the tops of the pans. Any spare spaces on the side have then been filled with freezing water, and the pans placed upon Fairbanks' scales. To get the temperatures of the surface, thermometers have been sunk so that two-thirds of the bulb was below the surface of the ice, with the stem nearly horizontal and in position to be read. Another glass suspended half an inch above the ice gave the temperature of the air. Temperatures were taken every fifteen minutes, and humidity, weight and wind every hour.

These examples (Tables of January 11th, 12th and 21st on page 612) will suffice to show that ice over a body of water, as in a reservoir, has a more uniform temperature than ice experimented on in the open air. It will be found warmer on a cold day and cooler on a warm day than the ice in an evaporometer.

The best place to experiment on the laws governing the evaporation from ice is in a covered and cold shed, through and into which the wind cannot penetrate.

* Manchester Memoirs.

TEMPERATURES OF ICE.

JANUARY 11TH, 1886.					JANUARY 12TH, 1886.				
Time.	Temp. Ice on Res.	Temp. Air over Res.	Temp. Ice in Gauge in Yard.	Temp. Air over Ice in Gauge.	Time.	Temp. Ice on Res.	Temp. Air over Res.	Temp. Ice in Gauge.	Temp. Air over Ice in Gauge.
Noon.	24.1	16.3	11.1	11.7	9 A.M.	9.7	-4.9	-6.9	-6.0
1 P.M.	24.1	16.3	13.3	13.8	10 "	15.4	-1.6	-5.6	-6.0
2 "	22.9	17.2	14.2	15.3	11 "	15.4	-1.6	-5.6	-2.7
3 "	22.3	16.0	13.3	13.8	12 M.	16.9	4.1	-4.2	-0.6
4 "	20.6	14.0	11.1	12.6	1 P.M.	17.8	5.5	-2.9	0.9
					2 "	15.4	6.1	-2.4	1.6

JANUARY 21ST, 1886.

Time.	No. 1.		No. 2.		No. 3.	
	Reservoir Surface.	Air.	Ice.	Air.	Ice.	Air.
			14 in. above Res.		Pan on Res.	
9 A.M.	32.4	31.1	29.7	30.4	30.6	30.4
10 "	32.4	33.8	32.0	34.3	32.0	33.8
11 "	32.7	34.3	32.5	35.4	32.5	35.6
12 M.	32.7	37.4	32.5	37.6	32.5	37.0
1 P.M.	32.7	40.1	32.5	38.8	32.5	37.9
2 "	32.5	38.7	32.5	38.7	32.5	37.9
3 "	32.5	37.9	32.9	38.5	32.5	37.9
4 "	32.4	34.7	32.5	37.2	32.5	34.7

FEBRUARY 17TH, 1886.

Time.	Ice.	Air.
9 A. M.	21.4	19.8
10 "	22.3	23.0
11 "	25.2	25.7
12 M.	27.9	27.9
1 P. M.	29.5	29.3
2 "	29.7	28.9
3 "	29.7	30.2
4 "	29.7	29.3
5 "	28.2	27.1

Here the temperature of the ice is more uniform, and follows pretty closely that of the air, as will be seen by the example (Tables of February 17th, 1886).

If the dew point be carefully determined by condensation, and the other observations are sufficiently accurate, it will be found that the rate of evaporation corresponds with that computed by means of the formula on page 589. The following experiment is selected as showing the different temperatures of an ice surface as determined by burying the bulb of a thermometer so that half its circumference was below the surface of the ice, as in column No. 1, and by simply allowing the thermometer to rest upon the ice, as in column No. 2.

FEBRUARY 24TH, 1886.

Time.	Temp. of Ice. Bulb Half Buried.	Temp. of Ice. Bulb Exposed.	Dry Bulb.	Wet Bulb.	Dew Point by Condensation.	Evaporation.
8 A.M.	23.4	21.9	16.0	15.0	10.6	Total, 0.0038 inch.
9 "	20.7	19.4	17.3	16.7	9.3	
10 "	20.3	19.8	18.0	17.0	12.2	
11 "	21.2	20.8	19.8	19.0	14.7	
12 M.	22.5	22.5	21.2	20.0	14.7	
1 P.M.	23.9	23.5	22.0	20.8	15.1	
2 "	24.3	23.9	22.2	21.0	14.2	
3 "	24.4	24.3	23.0	21.0	14.7	
4 "	24.3	24.3	22.3	20.5	13.6	
5 "	23.0	22.6	21.3	20.0	11.8	

The readings of the psychrometer and of a condensing hygrometer are both given in the above table, and the values of V and v may be selected according to the individual judgment, and according to the tables or formulas used for determining v and the dew point.

Taking the values of V from column No. 2, and the largest values of v which the notes give, the observed total evaporation in the nine hours, viz., 0.0038 inch, agrees almost perfectly with the amount, 0.0042 inch, computed by the formula, and taking any of the other values indicated above, does not lead to more serious differences than might be expected when the very small amounts of evaporation in this case are considered.

On the same day an experiment was made with an ice surface

exposed to a strong wind, with the following results: The mean force of vapor due to the temperature of the surface of the ice for 7 hours. 10 A.M. to 5 P.M., with the observations taken hourly, was 0.117 inch. The mean force of vapor in the air was 0.045 inch. The number of miles run by the wind (anemometer set at the same level with the ice) was 85.4, or 12.2 miles per hour. Here we have

$$\frac{(V-v) \left(1 + \frac{v}{2}\right)}{60} = \frac{.072 \times 7.1}{60} = 0.00852 \text{ inch}$$

per hour, or .0596 inch, total computed evaporation. The observed evaporation was .0575 inch. The range of temperature of the ice surface was 6 degrees, viz.: from 17.9 to 23.9 degrees.

There are many days in winter when the surface of the ice is very wet, or covered with pools of water. In forming an estimate of the evaporation, this fact should not be lost sight of.

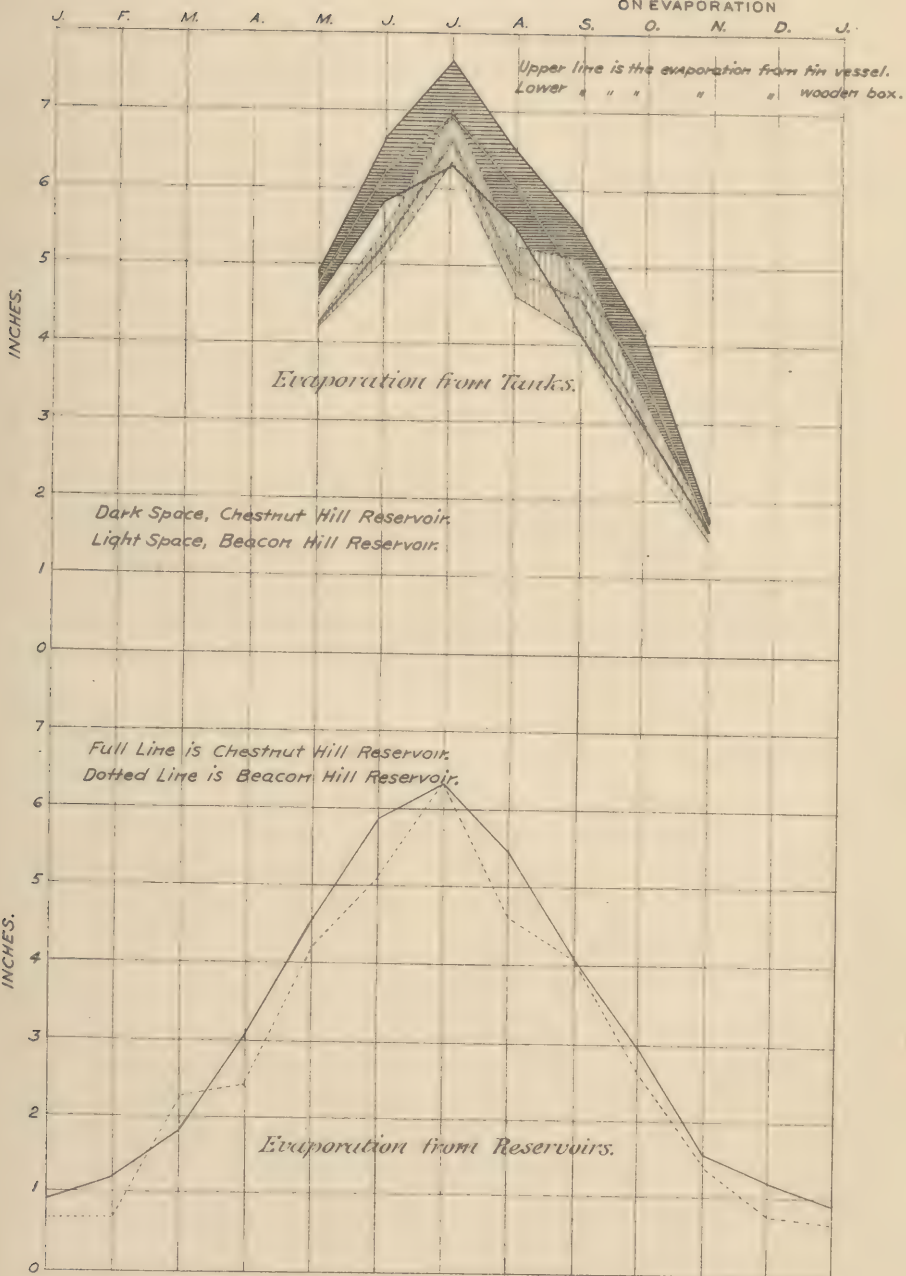
As already mentioned on page 601, the writer has known a reservoir to be losing vapor in the middle of December, at the rate of about a quarter of an inch per day, but this is most unusual. After much consideration and study of all the elements, the following figures have been adopted as an estimate of the mean evaporation from a large body of water during the winter and spring months:

December	1.20 inches.
January.....	0.90 "
February.....	1.20 "
March.....	1.80 "

In arriving at these values, the writer has been aided by plotting profiles of a number of experiments, and making allowances for what he believes to be the mean condition of the ice during the different months. Accuracy is not pretended for them, but in his judgment they are probably less than the true means, whatever these may be.

Plate LXXIX contains on its upper portion, profiles of the evaporation from box and pan at Chestnut Hill Reservoir, represented by the darker shaded space, and the same from the Beacon Hill Reservoir in a lighter tint, the upper line being the tin and the lower the box in each case, while the white space in the middle of each is the mean between the box and tin in both cases.

The lower portion of the same plate contains values for the reservoir evaporations. The Chestnut Hill profile is made up of the box evapora-



tions as recorded, and of the preceding values for the winter months, and completing the curve gives 3.10 inches for April.*

Finally, getting the months together, we have the following values:

January	0.90
February	1.20
March	1.80
April	3.10
May	4.61
June	5.86
July	6.28
August	5.49
September	4.09
October	2.95
November	1.63
December	1.20
Total	39.11

and we may find a mean curve by submitting these means to a mathematical computation, by the method of Bessel's Circular Function, which cannot fail to add very much to their value, in which, according to Sir John Herschel, the elements may be considered

First.—Independent of the others (or the mean).

Second.—The extent and law of its deviation from that amount.

Third.—Their mutual interdependence, or the reaction of each element on the rest.

The following is the formula:†

$$E = A + B_1 \sin (\Theta + C_1) + B_2 \sin (2 \Theta + C_2) + B_3 \sin (3 \Theta + C_3),$$

in which

E = evaporation in any one month in inches.

A = mean monthly amount.

$B_1 B_2 B_3$ = the parameter of its fluctuations for periods of 1, $\frac{1}{2}$ and $\frac{1}{3}$ year.

Θ = arc proportional to time, and inversely proportional to the period (360 degrees), or 30 degrees for one month.

* The writer once measured (1880) an evaporation of 1.31 inches in 8 days, in April.

† See Appendix No. 22 to the Report of the Superintendent of the Coast Survey for 1862; also Ency. Brit., 8th ed., article "Meteorology."

$C_1 C_2 C_3$ = angular constants having reference to the epochs of their respective periods.

MEAN CURVE OF EVAPORATION CORRECTED BY ABOVE FORMULA.*

	Inches.	Per Cent.
January	0.98	2.51
February.....	1.01	2.58
March	1.45	3.71
April	2.39	6.11
May.....	3.82	9.76
June.....	5.34	13.65
July.....	6.21	15.87
August.....	5.97	15.26
September	4.86	12.42
October.....	3.47	8.87
November.....	2.24	5.73
December	1.38	3.53
	39.12	100.00

The above values are plotted on Plate LXXX. They had already been secured before the writer thought of comparing them with the mean temperature; but the surprising correspondence of the two curves is very striking. The upper curve of dotted lines on the same diagram is the mean temperature for 15 years furnished by the United States Signal Office in Boston.

OTHER EXPERIMENTS.—AMERICAN.

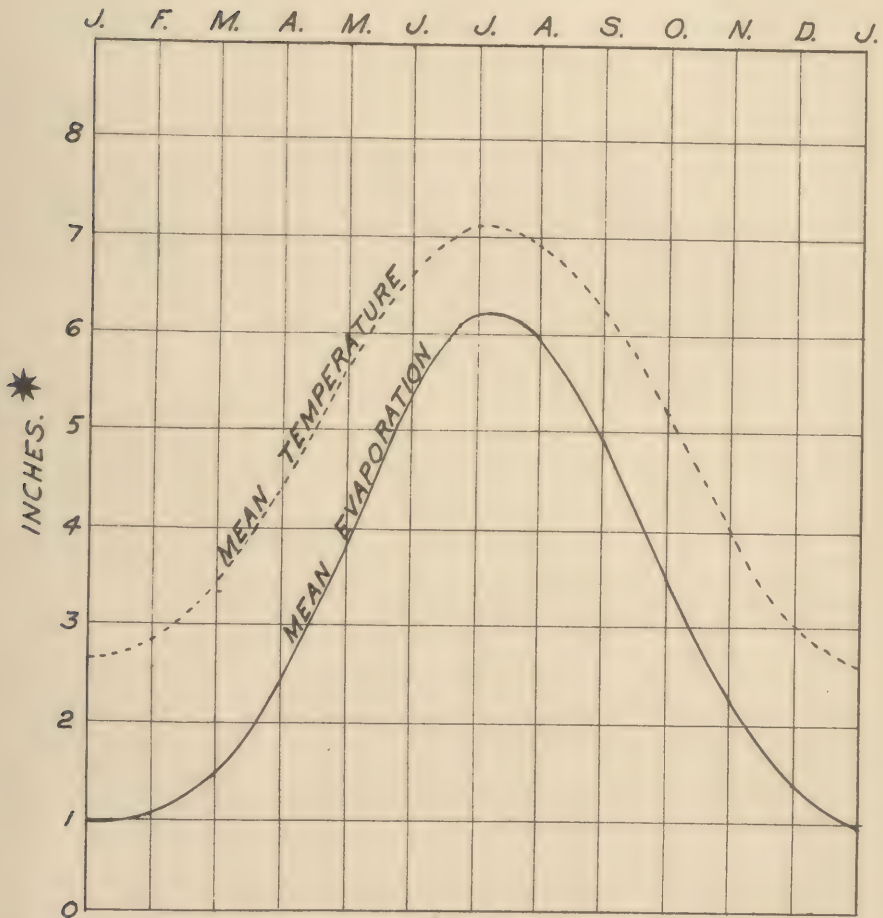
Evaporation experiments in this country are not numerous. Probably the earliest were made by Rev. Samuel Williams† in 1772, at Bradford, Mass.

Two vessels, 3 inches diameter and 6 inches deep, were used. It was found that by filling one of these vessels once a week and the other once a month, there was one-third more evaporation in the former case than in the latter. By floating one of his vessels in the Merrimac River during a week when there was little wind, still water and no rain, the result-

*The writer is aware that few engineers understand the value of the application of Bessel's circular function to a mass of observed periodic data, such as those under consideration. The labor of computation is considerable, but the results more than repay any time and trouble given to obtain them.

† Transactions Am. Phil. Soc., Vol. II, p. 119.

Mean Curve of Evaporation compared with Mean Temperature Curve.



* For the Temperature Curve add a cipher and read degrees instead of inches.

ing evaporation was as 1.15 inches to 1.50 inches in the freely exposed gauge.

Between 1865 and 1870, experiments were made on the Croton Water-works, both at the receiving reservoir and at Boyd's Corner, the latter by Mr. J. J. R. Croes, M. Am. Soc. C. E., to whom the writer is indebted for the details of the experiments.

"The mean annual evaporation for six years was 39.21 inches, 81 per cent. of the rainfall. Observations were made on the West Branch from June, 1866. to October, 1870. The apparatus consisted of a box 4 feet square and 3 feet deep, sunk in the earth in an exposed situation, and filled with water. The mean annual evaporation was found to be 24.15 inches, while from a similar box at the receiving reservoir the amount observed was 35.6 inches.

"Part of the difference may be due to difference of latitude, elevation, and distance from the sea-coast; but more is due, I think, to differences in the mode of measurement. My observations were made twice a day, and any apparent discrepancies were checked and corrected at once. The other observations were taken only once a month, the difference between rainfall and the reading of the gauge on the box being taken as the evaporation. I consider the method followed on the West Branch the more reliable. The box was zinc-lined, and readings made with hook gauge."

The following table gives the yearly amounts secured at the receiving reservoir:

	MONTHS.	BOX IN EARTH.	BOX IN RESERVOIR.	TIN IN RESERVOIR.
1865	10	35.24	36.05	39.19
1866	10	37.61	41.55	43.84
1867	9	31.08	33.98	34.75
1868	8	33.18	35.06	37.57
1869	8	29.85	34.57	39.93
Means.....		33.39	36.12	39.05

One year, 1870, is missing, but as we have above the mean, 39.21, given, we can supply the loss. It would require 54.65 for the box, and 39.98 for the tin, so that the results of the tin were probably taken; but

as for two of these years the observations only include 8 months; for one year, 9 months; and for two others, 10 months, it is obvious that the amount of 39.21 is not large enough. The only alternative is to consider the evaporation for the winter months so trifling, that it may be left out of the estimate altogether, which cannot be done, unless the investigations already shown are a failure.

The tin vessel at Chestnut Hill Reservoir was found to give too large results. It would be better to take the floating box and supply the missing months from the Boston experiments. First, let us see if there is a correspondence in the other months. The following table will show:

	NEW YORK.	BOSTON.
April.....	2.53	2.39
May.....	4.16	3.82
June.....	4.98	5.34
July.....	6.43	6.21
August.....	6.74	5.97
September.....	5.02	4.86
October.....	3.03	3.47
November.....	2.48	2.24
Total.....	35.37	34.30

This is believed to be a fair correspondence. Supplying the missing months, we get 39.64 as the mean for the five available years, or about 82 per cent. of the rainfall.

We now come to Mr. Croes' observations on a wooden box, sunk in the earth at Boyd's Corner, from which he deduced the low evaporation of 24.15 inches. The observations extended from July 1, 1866, to October, 1870, about four years. Mr. Croes has been unable to find the observations made in 1870, so that we have three complete years only with monthly results. One covers 10 months; one, 9 months; and one, 8 months, so that the evaporation needs certainly to be increased somewhat for the missing months, and probably somewhat for the fact of the gauge being unsurrounded with water; for we find the gauge correspondingly situated at the receiving reservoir gave less than the floating box. Even with these corrections, Mr. Croes' results are very much less than the others. As the experiments were made with greater care than at the

receiving reservoir, there is little doubt but that they represent the actual evaporation from the box as situated; but in the writer's opinion they cannot be accepted as representing the evaporation from a large body of water. Perhaps the water was colder, the velocity of the wind less, or the surface of the water may have been kept a greater distance below the top of the box than in the other experiments.

The following example is here brought in somewhat out of place as possibly illustrating the above.

At the Glencore filters,* South Pentlands, the evaporation from the surface of the water in a tub was observed for upwards of twenty years. The tub was 6 feet diameter and 3 feet deep. The description does not say how far below the top of the tub the water was usually kept, but from the following extract, the writer infers that the level must have been altogether too low to give good results. "The level of the surface of the water, when set at 0, is 1 foot below the top, thus making the depth only 2 feet." The mean rainfall 1857-80 was 38.8 inches, and the evaporation 11.42 inches. The reader is asked to compare this result with Mr. Greaves' experiments, page 620.

To give an idea of how considerable the mean evaporation from a large body of water must actually be in December, the writer would here call attention to the fact that Chestnut Hill Reservoir does not generally freeze over until the last of the month. During the years 1877-79 it did not vary more than one day from Christmas. In 1880 it closed in on the last of November, but the following year it was open until the 14th of January, which was also the case this year, 1886.

The ice generally disappears about the middle of March or 1st of April, but during some of this time the surface is in a very watery condition.

ENGLISH EXPERIMENTS.

Those made by the late Mr. Charles Greaves, C. E.,† are probably the best that have been published. They were taken from a floating slate gauge 3 feet square, with water from 3 to 7 inches in depth. The following table shows the rainfall and evaporation for fourteen years:

* Min. Inst. of Civil Engineers, Vol. LXXI, p. 74.

† Min. Proc. Inst. C. E., Vol. XLV, p. 19.

YEAR.	EVAPORATION.	RAINFALL.
1860.....	21.058	32.558
1861.....	25.008	23.633
1862.....	17.332	26.581
1863.....	18.266	19.766
1864.....	18.640	15.891
1865.....	20.124	29.248
1866.....	18.821	31.697
1867.....	20.061	27.436
1868.....	26.933	23.308
1869.....	19.062	24.562
1870.....	20.396	20.395
1871.....	19.583	24.083
1872.....	22.916	37.166
1873.....	20.395	23.770
Mean.....	20.613	25.721

The relation of the evaporation to the rainfall, 82 per cent., was about the same as in the experiments recorded by the writer.

The following table has been compiled from Mr. Greaves' paper.

MONTH.	EVAPORATION.	PER CENT.
January.....	0.755	3.6
February.....	0.603	2.9
March.....	1.065	5.2
April.....	2.098	10.2
May.....	2.753	13.4
June.....	3.142	15.2
July.....	3.443	16.7
August.....	2.849	13.8
September.....	1.606	7.8
October.....	1.056	5.1
November.....	0.669	3.3
December.....	0.574	2.8
Total.....	20.613	100.0

In the discussion which followed Mr. Greaves' paper (February, 1876), some valuable facts were elicited. Mr. Rogers Field stated that "British Rainfall" for 1869 gave the results of evaporation from thirteen stations as varying from 10 to 48 inches. English engineers had generally adopted 30 inches as the yearly evaporation. French engineers 51 to 59 inches at Paris, but experiments on the Canal de Bourgogne

gave 22 to 25 inches, and numerous experiments in different parts of France with brick tanks, had given from 18 to 25 inches. The difference in gauges was the key to the discrepancies.

Mr. Miller* found the mean evaporation to be 30 inches for six years from a small vessel fully exposed above ground. His monthly results are interesting, not as representing the true evaporation from a large body of water, but as giving the relations between the different months. The per cent. column has therefore been added.

MONTH.	EVAPORATION.	PER CENT.
January.....	0.880	2.9
February.....	1.042	3.5
March.....	1.770	5.9
April.....	2.535	8.4
May.....	4.146	13.9
June.....	4.547	15.1
July.....	4.200	14.0
August.....	3.398	11.3
September.....	3.174	10.6
October.....	1.930	6.4
November.....	1.322	4.4
December.....	1.087	3.6
Total.....	30.032	100.0

Mr. G. Dines, who has experimented much on evaporation, found† the loss from a small gauge, 5 inches diameter, $2\frac{1}{2}$ inches deep, all except the bottom exposed to the air, gave 76 per cent. more evaporation than a gauge 18 inches diameter.

Mr. Dines, Mr. Baldwin Latham and Mr. Rogers Field, among Englishmen, have all shown a lively interest in the subject of evaporation, and from their writings show that they understand the importance of the subject and the general principles upon which it depends. Mr. Latham has been experimenting on the subject for the Royal Society, but the results have not yet been published.

FRENCH EXPERIMENTS.

Among the best that the writer has been able to find, are those of

*Practical Treatise on Heat, Thomas Box, p. 147.

†Symon's Meteorological Mag., Vol V, p. 71.

Mr. A. Salles, whose observations were made at Arles.* He used three tanks of masonry, each 3 meters square (9 feet 10 inches), and containing 96.8 square feet. The depth of water was kept at about 1.6 feet in No. 1, 3 feet in No. 2, and 4.8 feet in No. 3. Special instruments were designed for accurate measurements. The general results were as follows. The mean annual evaporation was 41.3 inches. A Piche atmismometer gave 86.6 inches (this is a small instrument). The monthly evaporation varied from a minimum of practically 0 to 7.8 inches maximum in July. The greatest daily evaporation observed occurred on July 31, 1878. It was 0.56 inch in No. 1, and 0.55 inch in No. 2.

The engineers of the "Ponts et Chaussées" have found,† from numerous experiments on brick tanks at St. Jean de Losne, Dijon, Pouilly, and at Roche sur Yonne, that the mean annual evaporation is about 23 inches, or 73 per cent. of the rainfall. Once only in 1842, at Pouilly, did the evaporation exceed the rainfall.

RUSSIAN EXPERIMENTS.

An extensive series of comparative experiments has been conducted throughout the Russian Empire by H. Wild. The observations were taken at twenty-three different places, and covered periods from one to seven years, generally two years at each place. They are fully discussed in Mr. Ed. Stelling's able articles on the subject.‡ As the evaporations were all taken under shelter, and with a shallow weighing atmometer, known as "Wild's Wagevaporometer,"§ the results cannot give any idea of the real loss from a large body of water. They, however, form a basis for judging of the comparative evaporations at the different stations, as care was taken to have the conditions of exposure uniform. Two of Stelling's papers have been more fully noticed in the Theoretical discussion.

The writer has avoided dwelling at length in this paper on the many attempts to register evaporation by observations on small evaporating dishes freely exposed to the sun on the sides, and not immersed in water. Such attempts must inevitably result in failure to show, even approximately, the losses by evaporation from a large body of water.

* Comptes Rendus, 1883, Vol. XC VII, p. 347.

† Annales des Ponts et Chaussées, 2d Series, Vol. XX, p. 383.

‡ K. Academie der Wissenschaften, St. Petersburg, Repertorium VII-VIII, 1880-81.

§ Bulletin de l'Academie Impériale des Sciences de St. Petersburg, Vol. XIX.

Hourly Observations July 8th - 11th 1885.

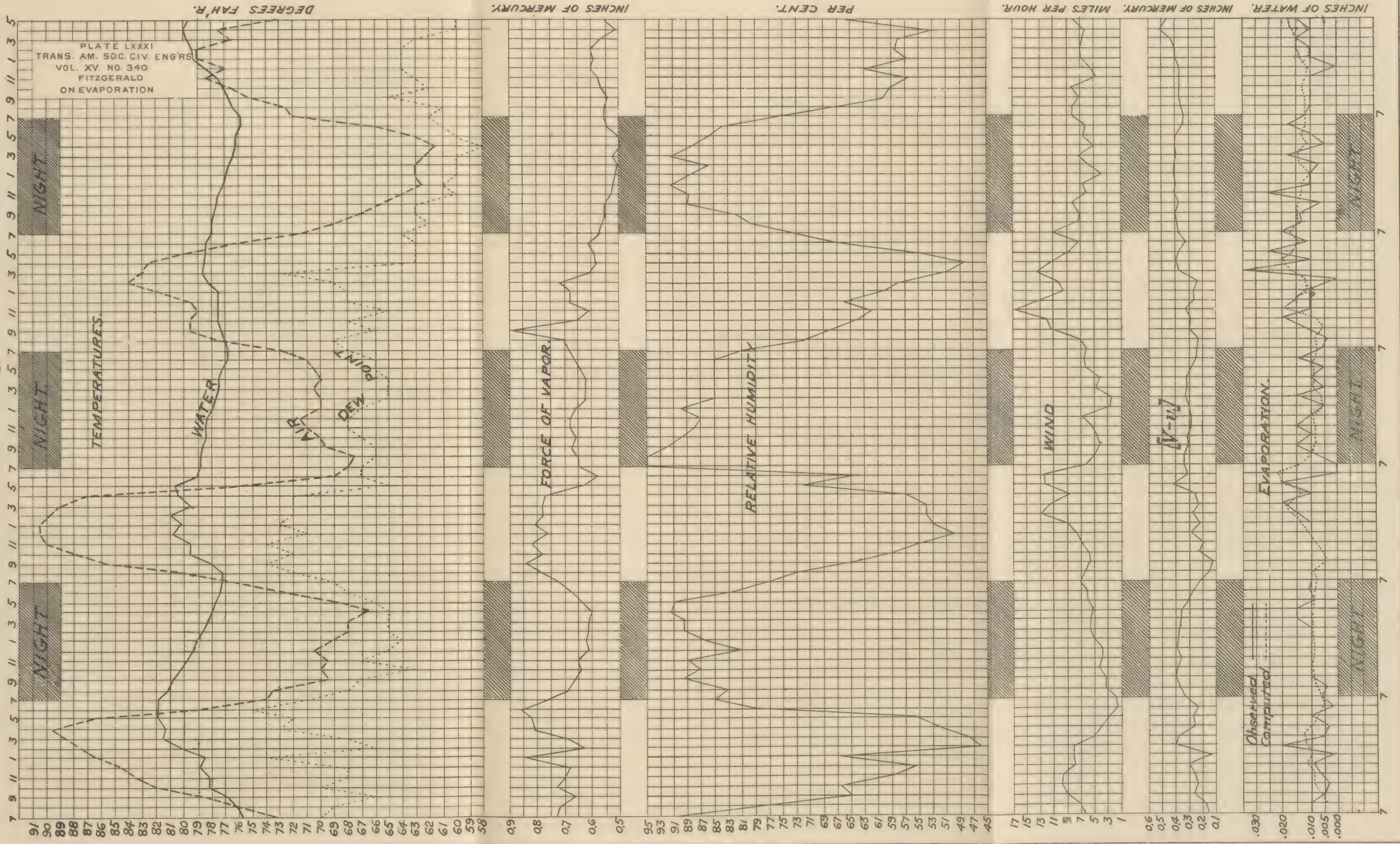


TABLE No. 1.
COMPARISON BETWEEN REGISTERING THERMOMETERS AND BAUDIN
STANDARD.

Reservoir.

DATE.	HUDDLESTON.			BAUDIN.			GREEN.		
	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.
1885.									
July 24.....	81.0	76.5	78.7	79.5	78.3	78.9	79.7	77.8	78.7
25.....	83.0	77.0	80.0	81.9	77.9	79.9	81.7	77.8	79.7
26.....	83.5	78.0	80.7	82.5	79.0	80.7	82.2	78.8	80.5
27.....	....	....	....	80.5	77.7	79.1	81.7	77.8	79.7
28.....	83.0	75.0	79.0	80.5	77.2	79.0	81.7	77.3	79.5
29.....	80.0	75.0	77.5	78.6	77.0	77.8	78.7	76.8	77.7
30.....	79.0	75.5	77.2	76.8	76.8	76.8	77.7	76.3	77.0
31.....	85.0	74.0	79.5	79.2	75.7	77.9	82.7	75.8	79.2
Aug. 1.....	81.0	76.0	78.5	77.9	76.8	77.3	80.2	76.3	78.2
2.....	79.0	75.0	77.0	76.8	76.2	76.5	77.7	74.8	76.2
3.....	77.0	74.0	75.5	76.0	74.9	75.4	76.2	74.8	75.5
4.....	78.0	74.0	76.0	77.0	74.1	75.5	76.7	73.8	75.2

Tank No. 1.

5.....	84.5	71.0	77.7	82.2	73.4	77.8	82.7	72.5	77.6
6.....	82.0	72.0	77.0	76.6	73.8	75.2	80.7	73.5	77.1
7.....	79.0	70.0	74.5	77.5	73.2	75.3	78.2	72.5	75.3
8.....	77.5	72.0	74.7	76.9	73.6	75.2	76.7	73.5	75.1
9.....	77.0	71.0	74.0	76.5	73.6	75.0	76.7	73.5	75.1
10.....	79.0	71.0	75.0	77.0	73.6	75.3	77.2	73.5	75.3
11.....	79.0	72.5	75.7	78.0	73.8	75.9	79.7	74.0	76.8
12.....	83.5	72.5	78.0	82.2	74.8	78.5	82.7	74.5	78.6
13.....	82.0	76.0	79.0	79.6	76.4	78.0	80.7	76.5	78.6
14.....	84.0	76.5	80.2	81.4	76.4	78.9	81.7	76.5	79.1
15.....	80.5	73.0	76.7	77.6	75.2	76.4	79.7	75.0	77.3
16.....	79.0	72.0	75.5	77.0	73.4	75.2	78.7	73.5	76.1
17.....	78.0	70.0	74.0	76.6	72.8	74.7	77.7	71.5	74.6
18.....	80.0	72.0	76.0	77.8	73.0	75.4	78.7	73.0	75.8
19.....	78.0	73.0	75.5	76.6	73.8	75.2	76.7	73.5	75.1
20.....	74.5	72.0	73.2	74.8	72.8	73.8	75.7	72.5	74.1
21.....	76.5	70.0	73.2	74.2	72.4	73.3	77.7	71.5	74.6
22.....	78.5	73.0	75.7	78.9	72.4	75.6	78.7	71.5	75.1
23.....	78.5	72.0	75.2	77.0	72.4	74.7	78.7	71.5	75.1
24.....	78.0	73.0	75.5	78.8	72.6	75.7	78.7	71.5	75.1
25.....	77.0	70.0	73.5	....	....	....	77.7	71.5	74.6
26.....	71.0	68.5	69.7	70.8	69.6	70.2	77.7	69.6	73.6
27.....	71.0	65.0	68.0	68.8	67.0	67.9	70.7	63.5	67.1
28.....	73.5	64.0	68.7	71.6	66.8	69.2	71.7	64.5	68.1
29.....	73.5	65.0	69.2	70.4	67.2	68.8	71.7	65.5	68.6
30.....	71.0	65.0	68.0	69.0	67.6	68.3	70.7	66.5	68.6
31.....	74.0	66.0	70.0	72.0	66.6	69.3	73.2	65.5	69.3
Sep. 1.....	75.0	66.0	70.5	72.4	66.6	69.5	73.7	66.0	69.8
2.....	71.0	66.0	68.5	67.3	66.4	66.8	70.7	66.0	68.3
3.....	71.0	62.0	66.5	69.0	65.0	67.0	69.2	64.0	66.6
4.....	75.0	64.0	69.5	72.3	65.4	68.8	73.3	64.5	68.9
5.....	71.0	67.0	69.0	69.4	67.2	68.3	70.7	67.0	68.8
6.....	73.0	63.0	68.0	70.0	65.8	67.9	69.7	65.0	67.3
7.....	70.0	65.5	67.7	69.0	65.6	67.3	69.7	64.5	67.1
8.....	73.0	64.0	68.5	69.7	65.2	67.4	72.7	64.5	68.6
9.....	74.0	64.0	69.0	72.6	65.6	69.1	73.7	65.0	69.3
10.....	68.0	62.5	65.2	64.8	63.8	64.3	67.7	63.8	65.7
11.....	68.5	61.0	64.7	67.2	63.2	65.2	67.7	62.5	65.1
12.....	73.0	61.0	67.0	70.8	63.0	66.9	71.7	62.0	66.8
13.....	69.0	62.0	65.5	68.0	63.4	65.7	68.7	63.0	65.8
14.....	75.0	65.0	70.0	73.4	64.4	68.9	73.7	64.5	69.1
15.....	73.0	67.0	70.0	72.4	67.2	69.8	73.2	67.0	70.1
16.....	72.0	67.0	69.5	70.0	67.0	68.5	72.7	66.5	69.6
17.....	71.0	65.0	68.0	69.0	65.4	67.2	71.7	65.4	68.5
18.....	71.0	64.5	67.7	69.4	64.6	67.0	69.7	64.0	66.8

TABLE No. 1.—(Continued.)

COMPARISON OF MAXIMUM AND MINIMUM THERMOMETERS WITH BAUDIN
STANDARD.

Tank No. 1.

DATE.	HUDDLESTON.			BAUDIN.			GREEN.		
	Max.	Min.	Mean.	Max.	Min.	Mean.	Max.	Min.	Mean.
1885.									
Sep. 19.....	69.5	65.0	67.2	67.3	65.4	66.3	68.7	64.5	66.6
20.....	68.0	63.0	65.5	66.5	64.8	65.6	66.7	63.5	65.1
21.....	68.5	61.0	64.7	67.0	65.0	66.0	66.7	62.5	64.6
22.....	66.5	62.0	64.2	65.6	64.6	65.1	65.7	62.5	64.1
23.....	.....	.....	.....	.....	.....	.....	.....	.....	.....
24.....	66.0	57.0	61.5	59.8	59.0	59.4	.....	.....	.....
25.....	67.0	57.5	62.2	61.8	59.4	60.6	66.7	.....	.....
26.....	67.0	56.5	61.7	66.0	59.2	62.6	66.2	58.0	62.3
27.....	70.0	58.5	64.2	68.0	60.4	64.2	69.7	69.0	64.3
28.....	67.5	61.0	64.2	66.6	62.0	64.3	66.7	61.5	64.1
29.....	67.0	61.0	64.0	65.4	62.4	63.9	66.7	61.5	64.1
30.....	66.5	60.5	63.5	65.2	62.0	63.6	65.7	61.0	63.3
Oct. 1.....	66.0	59.0	62.5	65.2	61.8	63.5	65.7	60.5	63.1
2.....	64.0	60.0	62.0	62.8	61.8	62.3	63.7	61.0	62.3
3.....	63.5	61.0	62.2	61.7	61.2	61.4	62.7	59.5	61.1
4.....	67.0	63.0	65.0	66.0	63.4	64.7	66.7	62.0	64.3
5.....	65.5	59.0	62.2	61.0	60.6	60.8	65.7	59.5	62.6
6.....	.....	.....	.....	.....	59.0	.....	.....	.....	.....
7.....	.....	.....	.....	56.8	56.8	56.8	.....	.....	.....
8.....	57.0	53.0	55.0	56.0	55.8	55.9	57.7	54.0	55.8
9.....	57.0	53.0	55.0	56.2	55.0	55.6	56.2	53.5	54.8
10.....	59.0	52.0	55.5	58.2	54.4	56.3	58.2	53.0	55.6
11.....	60.0	53.0	56.5	59.0	55.0	57.0	63.7	54.5	59.1
12.....	57.0	51.0	54.0	56.2	54.8	55.5	57.2	53.0	55.1
13.....	56.0	53.0	54.5	55.0	54.0	54.5	55.7	53.0	54.3
14.....	59.0	54.0	56.5	58.0	54.0	56.0	58.2	53.0	55.6
15.....	59.0	53.0	56.0	56.8	54.1	55.4	57.7	53.5	55.6
16.....	62.0	52.0	57.0	59.8	54.2	57.0	60.7	52.5	56.6
17.....	60.0	52.0	56.0	59.6	54.2	56.9	61.7	53.5	57.6
18.....	62.0	54.0	58.0	61.0	54.6	57.8	61.7	54.5	58.1
19.....	62.5	55.5	59.0	60.3	55.4	57.9	62.7	54.5	58.6
20.....	62.0	55.0	58.5	60.5	55.8	58.1	60.7	55.5	58.1
21.....	60.5	57.5	59.0	59.2	57.8	58.5	60.7	57.0	58.8
22.....	60.0	54.0	57.0	56.2	55.4	56.3	58.7	55.0	56.8
23.....	59.0	52.0	55.5	57.0	54.4	55.7	57.7	53.0	55.3
24.....	57.0	51.0	54.0	56.1	53.8	54.9	56.7	53.0	54.8
25.....	57.0	51.0	54.0	56.0	53.6	54.8	56.7	52.0	54.3
26.....	59.0	50.5	54.7	58.8	53.2	56.0	60.7	52.0	56.3
27.....	60.0	51.0	55.5	58.2	53.2	55.7	58.7	52.0	55.3
28.....	57.0	52.0	54.5	55.0	53.6	54.3	56.7	53.0	54.8
29.....	56.0	53.0	54.5	54.5	53.8	54.1	55.2	53.5	54.3
30.....	55.0	52.0	53.5	54.6	52.0	53.3	55.2	52.5	53.8
31.....	53.0	47.5	50.2	51.4	51.4	51.4	51.4	50.0	50.7

TABLE No. 1.—(Continued.)
COMPARISON OF MEAN TEMPERATURES.

RESERVOIR.				TANK No. 1.				TANK No. 1.			
DATE.	HDDLESTON REGISTERING.	BAYDIN.	GREEN REGISTERING.	DATE.	HDDLESTON REGISTERING.	BAYDIN.	GREEN REGISTERING.	DATE.	HDDLESTON REGISTERING.	BAYDIN.	GREEN REGISTERING.
1885.	Mean.	Mean.	Mean.	1885.	Mean.	Mean.	Mean.	1885.	Mean.	Mean.	Mean.
July 24....	78.7	78.9	78.7	Aug. 5....	77.7	77.8	77.6	Oct. 1....	69.8	69.5	69.8
25....	80.0	79.9	79.7	6....	77.0	75.2	77.1	2....	62.5	66.8	62.3
26....	80.7	80.7	80.5	7....	74.5	75.3	75.3	3....	62.0	66.6	62.3
27....	...	79.1	79.7	8....	74.7	75.4	75.1	4....	61.4	61.4	61.1
28....	...	79.0	79.5	9....	74.0	75.3	75.1	5....	64.4	64.3	64.3
29....	77.5	77.8	77.7	10....	75.0	75.3	75.3	6....	60.8	60.8	62.6
30....	77.2	76.8	77.0	11....	75.7	75.9	75.8	7....	...	...	...
31....	77.5	77.9	78.2	12....	78.0	78.5	78.6	8....	...	...	...
Aug. 1....	79.5	77.3	78.2	13....	79.0	78.0	78.6	9....	55.0	55.6	55.8
2....	77.0	76.5	76.2	14....	80.2	78.9	79.1	10....	55.5	56.3	55.6
3....	75.5	75.4	75.5	15....	76.7	76.4	77.3	11....	56.5	57.0	59.1
4....	76.0	75.5	75.2	16....	75.5	75.2	76.1	12....	54.0	55.5	55.1
Mean.....	78.1	77.9	78.1	17....	74.0	74.7	74.6	13....	54.5	54.5	54.3
				18....	76.0	75.4	75.8	14....	56.5	56.0	55.6
				19....	75.5	75.2	75.1	15....	56.0	56.0	55.6
				20....	73.2	73.8	74.1	16....	57.0	57.6	56.6
				21....	73.0	73.3	74.6	17....	56.0	57.5	57.6
				22....	75.7	75.6	75.1	18....	58.0	57.8	58.1
				23....	75.2	74.7	75.1	19....	59.0	57.9	58.6
				24....	75.5	75.7	75.1	20....	58.5	58.1	58.1
				25....	73.5	...	74.6	21....	59.0	58.5	58.8
				26....	69.7	70.2	73.6	22....	57.0	56.3	56.8
				27....	68.0	67.9	67.1	23....	55.5	55.7	55.3
				28....	68.7	69.2	68.1	24....	54.0	54.9	54.8
				29....	69.2	68.8	68.6	25....	54.0	54.4	54.3
				30....	68.0	68.3	68.6	26....	54.7	56.0	55.3
				31....	70.0	69.3	69.3	27....	55.5	55.7	55.3
				Mean.....	74.2	74.2	74.5	28....	54.5	54.3	54.8
								29....	54.5	54.1	54.3
								30....	58.5	58.3	58.8
								31....	50.2	51.4	50.7
				Mean.....	66.5	66.1	66.5	Mean.....	56.8	56.9	56.9

TABLE No. 2.
MEAN TEMPERATURE AND EVAPORATION FROM TANKS.

DATE.	RES.		TANK No. 1.		TANK No. 3.		TANK No. 2.		JUNE.	MEAN TEMP.	TOTAL EVAP.			
	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.						
1885														
May 11.....	52.2	57.1			0.11		0.11		{ Res... 30 days	{ No. 1. No. 3.	69.3	7.01		
12.....	52.7	56.1			0.25		0.29						7.86	
13.....	53.2	55.6			0.20		0.16							
14.....	52.7	44.6			0.16		0.19							
15.....	53.7	58.6			0.12		0.07		{ Res... 29 days	{ No. 1. No. 3.	69.5	6.90		
16.....	54.7	59.6	0.18	0.10	0.23		0.22						70.4	
17.....	56.7	59.1	0.17	0.18	0.23		0.24						7.75	
18.....	57.2	58.6	0.06	0.04	0.17		0.34							
19.....	60.2	64.1	0.13	0.10	0.67	0.10	0.66	0.10	{ Res... 23 days	{ No. 1. No. 3.	71.1	5.83		
20.....	59.6	61.3	0.19	0.16	0.34	0.27	63.1	0.29					72.0	
21.....	60.7	62.8	0.18	0.19	0.24	0.26	66.6	0.26					6.58	
22.....	61.9	64.1	0.16	0.16	0.25	0.25	66.9	0.26						
23.....	62.4	63.6	0.09	0.09	0.16	0.20	69.9	0.27	{ Res... 18 days	{ No. 1. No. 3.	72.5	4.58		
24.....	61.7	64.3	0.15	0.11	0.25	0.25	71.4	0.27					72.8	
25.....	63.7	60.1	0.06	0.07	0.25	0.25	74.0	0.20					5.29	
26.....	64.9	67.1	0.14	0.18	0.16	0.23	73.3	0.24					5.13	
27.....	65.7	67.3	0.16	0.25	0.13	0.23	73.3	0.24	{ Res... 18 days	{ No. 1. No. 3.	72.9	5.13		
28.....	66.7	65.1	0.16	0.25	0.30	0.35	75.3	0.30						
29.....	66.2		0.20	0.24	0.30	0.35	75.3	0.34						
30.....	65.4				0.27	0.34	73.6	0.32						
31.....	64.7				0.11		0.37	0.34	{ Res... 18 days	{ No. 1. No. 3.	72.9	5.13		
Total.....	1255.9	1099.1	2.04	3.02	73.5	0.31	73.0	0.25					73.8	0.27
Mean.....	59.8	61.1	0.16	0.15	69.8	0.57	69.9	0.58					70.8	0.64
21 days	18 days	14 days	20 days	20 days	69.8	0.44	69.4	0.49					70.1	0.50

TABLE No. 2.—(Continued.)
MEAN TEMPERATURE AND EVAPORATION FROM TANKS.

DATE.	TANK No. 1.		TANK No. 2.		TANK No. 3.		TANK No. 5.		TANK No. 6.		JULY.	MEAN TEMP.	TOTAL EVAP.
	RES.	Mean Temp.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.			
July 1885.													
1.....	71.0	69.4	71.0	0.33	70.4	0.33	.....	.....	.....	.....	Res.	77.3	.....
2.....	71.0	70.8	71.4	0.27	70.9	0.33	.....	.....	.....	.....	No. 1....	77.2	7.14
3.....	71.8	71.5	72.0	0.20	71.6	0.26	.....	.....	.....	.....	No. 2....	77.7	8.04
4.....	74.4	75.1	75.6	0.13	74.3	0.16	.....	.....	.....	.....	No. 3....	77.2	7.99
5.....	74.5	75.4	75.4	0.17	75.4	0.20	.....	.....	.....	.....			
6.....	74.4	74.3	74.9	0.18	74.7	0.19	.....	.....	.....	.....			
7.....	75.3	75.7	76.0	0.13	75.3	0.27	.....	.....	.....	.....			
8.....	78.7	78.8	79.4	0.12	78.4	0.13	75.5	0.31	75.3	0.26	Res.	78.3	5.86
9.....	79.1	79.9	80.2	0.22	79.4	0.13	79.1	0.14	79.0	0.16	No. 1....	78.3	6.58
10.....	77.7	77.8	78.3	0.29	77.7	0.30	79.2	0.31	79.2	0.20	No. 2....	78.7	6.52
11.....	77.8	77.7	78.3	0.30	77.5	0.29	77.7	0.21	77.6	0.30	No. 3....	78.2	6.54
12.....	77.1	76.8	77.5	0.31	77.5	0.39	77.1	0.30	77.3	0.28	No. 5....	78.0	6.54
13.....	76.8	76.2	76.8	0.24	76.4	0.38	76.5	0.38	76.4	0.34	No. 6....	78.0	6.35
14.....	74.5	74.2	74.5	0.29	74.3	0.30	76.8	0.27	75.8	0.25			
15.....	75.3	75.9	75.6	0.19	74.3	0.23	73.6	0.22	73.5	0.20			
16.....	78.1	77.8	78.0	0.21	74.9	0.25	74.9	0.27	74.9	0.25			
17.....	78.4	79.7	79.3	0.17	78.7	0.19	78.1	0.24	78.0	0.24			
18.....	80.3	80.2	80.5	0.20	80.5	0.26	78.9	0.22	78.9	0.20			
19.....	78.7	79.4	79.0	0.33	79.3	0.37	80.3	0.35	80.2	0.25			
20.....	80.4	80.1	80.6	0.25	80.4	0.29	80.1	0.30	80.1	0.29			
21.....	79.3	79.3	79.4	0.36	79.4	0.37	78.2	0.37	78.2	0.33			
22.....	80.1	80.1	80.1	0.22	79.5	0.32	79.7	0.30	79.5	0.32			
23.....	80.6	80.1	80.8	0.28	79.7	0.30	79.6	0.28	79.6	0.29			
24.....	78.9	79.0	79.2	0.28	78.8	0.34	79.8	0.33	79.8	0.32			
25.....	80.0	80.9	81.2	0.14	80.0	0.31	78.4	0.27	78.5	0.29			
26.....	80.7	80.7	80.3	0.24	80.7	0.20	80.7	0.17	80.2	0.16			
27.....	79.1	79.3	80.1	0.33	78.8	0.44	77.5	0.21	80.3	0.21			
28.....	79.0	78.2	78.6	0.28	78.3	0.34	78.5	0.38	77.8	0.39			
29.....	77.8	76.0	77.4	0.20	77.5	0.34	78.1	0.36	78.1	0.33			
30.....	76.8	76.2	76.7	0.17	76.7	0.24	77.3	0.21	77.3	0.23			
31.....	77.9	77.6	79.6	0.12	79.0	0.09	75.8	0.10	75.8	0.11			
Total.....	.....	.....	.....	7.14	.....	7.99	.....	6.54	.....	6.35			
Mean.....	77.3	77.2	77.7	0.23	77.2	0.26	78.0	0.25	78.0	0.25			
							25 days.	25 days.	25 days.	25 days			

TABLE No. 2 (Continued).
MEAN TEMPERATURE AND EVAPORATION FROM TANKS.

DATE.	RES.	Tank No. 1.		Tank No. 2.		Tank No. 3.		Tank No. 4.		Tank No. 5.		Tank No. 7.		AUGUST	MEAN TEMP.	TOTAL EVAP.
		Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.			
1885.																
Aug.																
1	77.3	77.0	0.07	78.5	0.068	77.9	0.09	77.3	0.09	78.3	0.09	...	...	Res.	74.4	7.41
2	76.5	75.9	0.07	76.8	0.09	76.5	0.09	76.3	0.09	76.5	0.09	...	...	No. 1.	74.4	7.05
3	75.4	74.9	0.08	75.5	0.17	75.1	0.17	75.0	0.22	74.4	0.19	...	...	No. 2.	75.0	6.93
4	75.5	76.0	0.07	76.1	0.09	75.7	0.16	75.8	0.26	75.0	0.14	...	...	No. 3.	74.4	6.78
5	77.9	77.8	0.31	79.2	0.25	77.9	0.26	78.4	0.25	78.2	0.26	...	...	No. 4.	74.4	6.93
6	76.0	75.2	0.34	76.5	0.32	75.8	0.32	76.0	0.29	75.0	0.31	...	...	No. 5.	74.0	
7	75.2	75.3	0.31	76.9	0.28	75.3	0.27	75.3	0.25	74.7	0.27	...	...			
8	75.0	75.4	0.27	75.6	0.26	75.0	0.26	74.9	0.26	74.6	0.26	75.2	0.27			
9	74.8	75.0	0.22	75.1	0.23	75.0	0.23	75.0	0.22	74.0	0.23	74.5	0.25	Res.	74.0	6.27
10	75.0	75.3	0.20	76.0	0.18	75.2	0.20	75.4	0.18	75.2	0.20	75.0	0.22	No. 1.	74.0	6.04
11	75.6	75.9	0.23	76.1	0.16	75.5	0.18	75.4	0.14	75.3	0.16	75.0	0.23	No. 2.	74.5	5.84
12	76.8	78.5	0.20	78.2	0.14	77.4	0.14	77.6	0.15	77.9	0.10	79.0	0.14	No. 3.	73.9	5.85
13	77.5	78.0	0.17	77.4	0.14	77.3	0.13	77.5	0.13	77.5	0.14	78.4	0.15	No. 4.	73.6	5.85
14	78.1	78.9	0.25	78.7	0.20	78.0	0.21	78.1	0.21	78.2	0.21	79.1	0.20	No. 5.	73.9	
15	76.3	76.4	0.37	76.7	0.38	75.8	0.33	75.0	0.38	75.1	0.35	75.1	0.39			
16	75.5	75.2	0.30	75.8	0.32	75.1	0.32	75.1	0.30	74.1	0.32	74.2	0.24	25 days.		5.43
17	75.0	74.7	0.31	75.7	0.36	75.1	0.32	75.0	0.33	74.6	0.34	74.9	0.29			
18	75.0	75.4	0.28	75.7	0.26	74.8	0.26	74.9	0.27	74.8	0.26	75.4	0.26			
19	74.9	75.2	0.24	75.6	0.20	75.0	0.19	75.1	0.20	74.7	0.20	75.3	0.20			
20	74.5	73.8	0.36	74.8	0.34	74.1	0.33	74.0	0.31	73.4	0.34	73.5	0.28			
21	73.5	73.3	0.23	73.9	0.24	73.4	0.22	73.3	0.22	72.7	0.22	72.8	0.20			
22	74.9	75.6	0.19	76.5	0.24	75.5	0.22	75.5	0.22	75.7	0.22	76.4	0.22			
23	73.9	74.7	0.29	74.5	0.24	74.0	0.24	73.9	0.22	73.7	0.20	74.1	0.19			
24	74.4	75.7	0.11	76.0	0.10	75.2	0.11	75.8	0.15	75.5	0.14	76.7	0.13			
25	73.7	74.4	0.05	73.0	0.05	72.7	0.05	72.9	0.05	72.5	0.05	73.0	0.05			
26	71.9	70.2	0.48	71.6	0.50	71.1	0.45	70.9	0.36	70.5	0.45	69.3	0.40			
27	70.9	67.9	0.18	70.4	0.50	69.6	0.45	68.4	0.42	67.9	0.45	67.4	0.39			
28	70.0	69.2	0.28	70.7	0.27	69.8	0.27	69.7	0.27	68.7	0.28	68.3	0.23			
29	70.0	68.8	0.24	69.8	0.28	69.2	0.26	69.2	0.25	68.6	0.28	69.0	0.24			
30	68.3	68.3	0.12	68.9	0.11	68.4	0.12	68.5	0.08	68.2	0.10	68.5	0.09			
31	69.4	69.3	0.19	70.8	0.08	69.7	0.06	69.8	0.04	69.5	0.06	70.6	0.05			
Total.	...	...	7.41	...	7.05	...	6.53	...	6.78	...	6.93	...	5.43			
Mean.	74.4	74.4	0.24	75.0	0.23	74.4	0.22	74.4	0.22	74.0	0.22	73.9	0.22	25 days.		

* Assumed from data.

TABLE NO. 2—(Continued).
MEAN TEMPERATURE AND EVAPORATION FROM TANKS.

DATE.	Temp. Res.	Tank No. 1.		Tank No. 2.		Tank No. 3.		Tank No. 4.		Tank No. 5.		Tank No. 7.		SEPT. MEAN.	MEAN TEMP.	TOTAL EVAP.
		Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.			
1885.																
Sep. 1	63.4	69.5	.17	70.3	.18	69.6	.18	69.6	.18	69.2	.18	70.0	.17	Res. ..	66.0	....
2	67.6	66.8	.33	68.0	.38	67.3	.35	67.2	.36	66.4	.35	66.2	.35	No. 1..	66.0	5.13
3	67.2	67.9	.23	67.9	.28	67.0	.27	67.0	.28	66.4	.26	66.7	.24	No. 2..	66.6	5.81
4	67.7	68.8	.15	69.1	.17	68.1	.16	68.2	.15	68.0	.15	69.0	.14	No. 3..	66.7	5.64
5	68.6	68.3	.07	68.1	.04	68.7	.04	68.5	.04	68.5	.04	69.1	.07	No. 4..	66.0	5.62
6	68.2	67.9	.19	68.5	.23	67.7	.21	67.9	.22	67.8	.20	66.0	.18	No. 5..	64.9	5.30
7	67.3	67.3	.17	67.6	.21	67.0	.21	67.0	.21	67.8	.20	66.3	.18	No. 6..	65.5	5.06
8	67.6	67.4	.17	67.7	.19	66.9	.17	67.1	.18	66.2	.17	66.9	.16			
9	67.6	69.1	.11	69.1	.10	68.0	.11	68.3	.04	67.7	.10	69.0	.10			
10	66.8	64.3	.27	66.0	.24	65.2	.26	65.0	.29	63.2	.24	63.6	.19			
11	65.6	65.2	.17	66.2	.22	65.4	.22	65.7	.22	64.0	.21	65.0	.18			
12	67.5	66.9	.16	68.3	.21	67.2	.20	67.6	.20	66.5	.13	67.4	.17			
13	66.1	65.7	.14	66.9	.19	66.2	.19	66.5	.18	66.0	.17	67.2	.18			
14	66.3	68.9	.10	68.2	.09	66.9	.09	68.1	.11	67.3	.12	69.2	.10			
15	68.2	69.8	.09	68.7	.08	67.9	.08	68.5	.09	67.8	.09	69.1	.11			
16	68.0	68.5	.18	68.1	.21	66.6	.21	67.9	.21	66.0	.20	66.3	.20			
17	67.5	67.2	.24	68.6	.27	67.4	.24	67.7	.26	66.4	.24	66.6	.21			
18	66.7	67.0	.20	67.0	.23	66.3	.22	66.7	.20	65.5	.21	66.3	.20			
19	67.6	66.3	.19	66.8	.22	66.2	.21	66.3	.21	65.7	.22	65.4	.20			
20	67.1	65.6	.20	67.6	.25	66.4	.24	66.6	.24	64.1	.22	65.3	.19			
21	66.2	66.0	.15	66.4	.22	65.6	.22	66.0	.22	64.4	.20	64.4	.15			
22	65.3	65.1	.13	65.5	.17	64.9	.16	65.0	.16	63.7	.15	64.0	.14			
23	62.3	62.0	.34	62.5	.58	61.8	.55	62.0	.56	60.7	.50	61.2	.50			
24	60.0	59.4	.30	60.3	.59	59.6	.55	59.5	.56	58.2	.50	58.7	.50			
25	62.1	60.6	.14	62.3	.22	61.6	.21	61.8	.20	60.5	.14	62.0	.17			
26	62.1	62.6	.13	63.0	.16	62.1	.17	62.7	.16	61.2	.14	62.2	.15			
27	63.2	64.2	.06	64.9	.11	63.3	.11	63.9	.11	63.1	.11	64.8	.09			
28	63.9	64.3	.07	64.9	.07	64.0	.07	64.5	.10	63.5	.08	64.7	.08			
29	63.8	63.9	.10	63.9	.13	63.4	.12	63.7	.10	62.5	.11	63.1	.11			
30	63.8	63.6	.12	64.0	.16	63.6	.17	63.8	.16	63.0	.17	63.1	.15			
Total...	...	5.13		...		...		...		...		...				
Mean...	66.0	66.0	0.17	66.6	0.19	65.7	0.19	66.0	0.19	64.9	0.18	65.6	0.17			

TABLE NO. 2—(Continued).
MEAN TEMPERATURE AND EVAPORATION FROM TANKS.

DATE.	Res. Mean Temp.	Tank No. 1.		Tank No. 2.		Tank No. 3.		Tank No. 4.		Tank No. 5.		Tank No. 7.		OCTOBER.	MEAN TEMP.	TOTAL EVAP.
		Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.	Mean Temp.	Evap.			
1885.																
Oct. 1	63.3	63.5	.14	63.7	.17	63.0	.16	63.4	.16	62.6	.15	62.7	.16	{ Res. . .	57.3	2.79
2	62.7	62.3	.08	62.8	.00	62.2	.00	62.3	.00	60.9	.00	61.2	.00	{ No. 1. . .	56.6	3.47
3	61.7	61.4	.00	61.9	.00	62.0	.00	62.2	.00	61.3	.00	61.3	.00	{ No. 2. . .	57.7	3.39
4	63.3	64.4	.10	63.8	.26	63.4	.26	63.6	.25	63.1	.12	63.8	.20	{ No. 3. . .	57.0	3.50
5	61.9	60.3	.25	61.6	.38	61.3	.36	61.3	.30	59.4	.35	59.4	.35	{ No. 4. . .	56.1	3.12
6	59.8	58.0	.11	59.8	.19	58.8	.20	59.0	.19	57.0	.19	58.5	.17	{ No. 5. . .	56.1	3.05
7	59.2	56.8	.24	59.2	.19	58.7	.20	58.8	.19	55.9	.19	55.4	.17	{ No. 7. . .	56.1	
8	57.7	55.9	.14	58.4	.23	57.6	.23	57.8	.22	55.6	.21	55.4	.18			
9	57.9	56.6	.17	57.9	.23	57.3	.23	57.4	.22	53.3	.21	55.4	.18			
10	57.5	56.3	.15	57.8	.18	57.1	.18	57.5	.18	55.7	.17	56.3	.17			
11	57.5	57.0	.10	57.8	.13	57.2	.13	57.7	.13	56.1	.13	56.7	.12			
12	56.8	55.5	.14	56.9	.19	56.2	.18	56.4	.18	54.9	.18	54.2	.18			
13	56.2	54.3	.10	56.3	.08	55.4	.08	55.7	.08	55.0	.08	54.7	.08			
14	56.4	56.0	.02	57.2	.03†	56.7	.03†	57.3	.03†	56.6	.03†	56.8	.03†			
15	55.9	56.0	.10	57.1	.14	56.2	.13	56.8	.15	55.9	.14	56.0	.13			
16	57.1	57.6	.10	58.8	.12	57.4	.12	58.2	.12	56.8	.12	57.3	.11			
17	56.3	57.5	.07	58.8	.10	57.5	.09	58.3	.09	57.0	.09	57.3	.08			
18	57.9	57.8	.07	57.8	.09	56.4	.09	57.5	.10	57.8	.09	58.3	.10			
19	57.9	57.9	.03	58.5	.05	57.6	.04	58.4	.04	58.1	.06	58.3	.04			
20	58.0	58.1	.06	58.9	.07	57.7	.06	58.8	.07	58.0	.06	58.5	.07			
21	57.4	58.5	.01	58.5	.04	58.2	.04	58.4	.04	58.4	.05	58.0	.04			
22	56.3	56.3	.30	57.2	.18	56.6	.16	56.8	.19	55.0	.19	54.0	.18			
23	56.6	56.7	.11	56.5	.13	56.1	.16	56.0	.16	54.9	.14	54.7	.13			
24	56.0	54.9	.10	56.7	.13	56.3	.12	56.3	.12	53.8	.09	53.4	.09			
25	56.0	56.0	.06	56.7	.12	54.8	.11	54.7	.12	53.4	.10	53.1	.10			
26	56.0	56.0	.06	56.3	.10	55.8	.11	56.3	.10	55.1	.05	55.5	.08			
27	55.4	56.7	.07	56.2	.11	55.4	.09	55.8	.11	55.0	.09	55.4	.08			
28	54.8	54.3	.04	56.2	.06	55.0	.06	55.0	.06	54.8	.05	54.9	.05			
29	54.7	54.1	.00	54.7	.00	54.7	.00	54.7	.00	54.3	.00	54.3	.00			
30	54.6	53.3	.03	54.4	.04†	53.8	.04†	53.7	.04†	52.0	.04†	52.0	.04†			
31	53.4	51.4	.19	53.2	.23	53.7	.24	52.5	.24	50.1	.20	49.6	.19			
Total.	57.6	57.0	3.07	58.0	3.47	57.4	3.39	57.7	3.50	56.5	3.12	56.5	3.05			
Mean . . .			0.12		0.12		0.12		0.12		0.11		0.11			
			28 days.		28 days.		28 days.		28 days.		28 days.		28 days.			

* No observation. † Assumed.

TABLE No. 3.
HOURLY OBSERVATIONS MAY 19-20, 1885.

DATE.	TIME.	TEMPERATURE AT SURFACE—FAHR.		EVAPORATION, INCHES.		Temp. of Air.	Dew Point.	Force of Vapor.	Relative Humidity.
		Res.	Tank No. 1.	Tank No. 1.	Tank No. 3.				
May 19. 1885.	5 P.M.	64.0	68.9	.....	.....	83.0	75.0	0.455	89.9
	6 " " " "	63.1	68.0	0.007	0.005	74.0	61.0	0.542	60.3
	7 " " " "	64.2	66.7	0.008	0.005	75.0	52.0	0.591	46.5
	8 " " " "	63.1	65.3	0.007	0.010	71.0	62.0	0.387	51.0
	9 " " " "	61.3	64.0	0.008	0.010	68.0	54.0	0.400	68.0
	10 " " " "	61.3	63.5	0.009	0.000	67.0	60.0	0.413	62.0
	11 " " " "	61.3	62.6	0.009	0.010	63.0	55.0	0.430	75.0
	12 " " " "	61.5	62.1	0.009	0.000	63.0	54.0	0.415	72.3
	1 A.M.	61.3	61.7	0.004	0.010	60.5	54.0	0.412	77.4
	2 " " " "	61.3	61.7	0.005	0.000	59.0	51.5	0.432	89.0
	3 " " " "	61.3	61.5	0.004	0.010	62.5	55.5	0.438	77.4
	4 " " " "	61.3	61.2	0.005	0.000	59.5	54.0	0.426	82.2
May 20.	5 " " " "	61.3	60.8	0.005	0.005	61.3	53.0	0.400	72.3
	6 " " " "	61.0	60.8	0.005	0.005	61.0	53.0	0.403	74.3
	7 " " " "	60.4	60.8	0.003	0.005	61.0	54.0	0.407	74.8
	8 " " " "	60.3	60.8	0.004	0.005	60.0	47.0	0.392	60.5
	9 " " " "	59.5	61.2	0.007	0.020	59.0	50.0	0.372	75.8
	10 " " " "	59.0	61.0	0.017	0.010	57.7	46.5	0.320	64.5
	11 " " " "	58.3	61.7	0.016	0.005	58.3	49.0	0.351	70.3
	12 " " " "	59.5	61.7	0.016	0.005	56.5	47.0	0.399	71.8
	1 P.M.	58.3	61.7	0.011	0.020	56.0	46.0	0.308	66.3
	2 " " " "	61.0	61.7	0.011	0.005	58.0	46.0	0.310	59.9
	3 " " " "	61.0	61.7	0.011	0.005	58.8	46.0	0.308	59.7
	4 " " " "	61.0	61.7	0.011	0.010	58.0	45.5	0.303	59.5
	5 " " " "	60.4	61.3	0.011	0.005	57.0	46.0	0.309	64.1
	Total	1 526.0	1 564.1	0.204	0.105	1 568.1	1 304.0	9.553	1 680.9
	Mean	61.0	62.6	0.0085	0.0069	62.4	61.8	0.386	67.0
Means	{ Night	62.0	63.7	0.0067	0.0054	66.2	55.3	0.426	66.9
	{ Day	60.0	61.3	0.0103	0.0083	58.6	48.3	0.346	67.1

TABLE No. 3.—(Continued.)
HOURLY OBSERVATIONS JUNE 23-24, 1885.

Date.	Time.	TEMPERATURE AT SURFACE—FAHR.				EVAPORATION, INCHES.				Temp. of Air.	Dew Point.	Force of Vapor.	Relative Humidity	Wind. Miles Per Hour.
		Tank No. 1.	Tank No. 2.	Tank No. 3.	Res.	Tank No. 1.	Tank No. 2.	Tank No. 3.	Tank No. 3.					
June 23.....	5 P.M....	71.4	71.5	70.5	70.5	.....	.....	.....	.....	69.0	44.0	0.291	41.0	.....
	6	70.9	70.0	70.9	70.2	0.020	0.010	0.005	0.005	68.0	41.0	0.259	40.0	11.5
	7	71.1	70.0	70.5	70.0	0.011	0.020	0.015	0.015	68.8	43.0	0.281	42.0	10.1
	8	70.7	69.8	70.3	69.6	0.011	0.010	0.010	0.010	68.0	43.0	0.269	42.0	8.7
	9	70.5	69.6	70.3	69.6	0.013	0.010	0.015	0.015	66.8	47.0	0.311	46.0	3.3
	10	70.3	69.4	70.3	69.4	0.020	0.020	0.015	0.015	67.0	45.0	0.304	46.0	4.4
	11	70.3	69.3	70.0	69.1	0.020	0.020	0.020	0.020	67.8	43.0	0.284	43.0	7.3
	12	70.2	69.1	69.3	68.9	0.020	0.010	0.010	0.010	66.8	43.0	0.278	42.0	7.8
	1 A.M....	70.2	68.9	68.3	68.7	0.020	0.010	0.020	0.020	64.5	43.0	0.301	41.0	6.8
	2	69.6	68.5	68.4	68.7	0.020	0.020	0.020	0.020	66.1	43.0	0.307	40.0	8.7
	3	69.4	68.2	68.3	68.4	0.022	0.020	0.020	0.020	66.8	43.0	0.299	40.0	8.7
	4	69.3	68.2	68.3	68.4	0.022	0.020	0.020	0.020	66.7	39.0	0.246	41.0	12.9
June 24.....	5	69.3	68.0	68.1	68.2	0.021	0.020	0.020	0.020	66.7	39.0	0.269	41.0	13.3
	6	69.1	67.8	68.1	68.2	0.015	0.010	0.020	0.020	65.0	42.0	0.266	40.0	15.5
	7	69.1	67.8	68.1	68.2	0.015	0.010	0.020	0.020	64.2	44.0	0.285	48.0	16.6
	8	69.3	68.2	68.1	68.9	0.015	0.020	0.020	0.020	67.0	43.0	0.274	41.0	16.6
	9	69.3	68.2	68.4	69.3	0.015	0.020	0.020	0.020	68.5	44.0	0.289	42.0	19.1
	10	69.6	68.5	70.0	69.6	0.015	0.020	0.020	0.020	71.5	42.0	0.289	37.0	18.0
	11	69.8	68.7	70.5	70.2	0.010	0.010	0.020	0.020	74.2	45.0	0.301	36.0	20.6
	12	70.0	69.3	70.9	70.5	0.018	0.040	0.020	0.020	76.0	45.0	0.306	34.0	17.4
	1 P.M....	70.2	69.8	71.1	70.7	0.018	0.010	0.020	0.020	78.5	46.5	0.322	32.0	16.0
	2	70.5	70.2	70.9	70.7	0.019	0.020	0.020	0.020	79.3	47.5	0.328	33.0	13.7
	3	70.5	70.0	70.5	70.3	0.020	0.020	0.020	0.020	78.3	48.0	0.342	38.0	11.8
	4	70.3	70.0	70.2	70.0	0.020	0.020	0.020	0.020	79.0	53.5	0.412	41.0	10.0
Total		1750.9	1726.7	1750.6	1735.1	0.420	0.500	0.490	0.490	1635.5	1108.0	7.370	1240.0	285.1
Mean		70.0	69.0	70.0	69.4	0.0175	0.0208	0.0204	0.0204	64.5	44.1	0.292	50.0	11.9
Means	Night	70.3	69.2	70.0	69.2	0.0182	0.0208	0.0183	0.0183	68.5	43.6	0.284	58.9	8.2
	Day	69.7	68.8	70.0	69.5	0.0168	0.0208	0.0225	0.0225	70.5	44.7	0.300	41.1	16.6

TABLE No. 3.—(Continued.)
HOURLY OBSERVATIONS JUNE 24-25, 1885.

DATE.	TIME.	TEMPERATURE AT SURFACE—FAHR.				EVAPORATION, INCHES.			Temp. of Air.	Dew Point.	Force of Vapor.	Relative Humidity.	WIND, Miles Per Hour.
		Tank No. 1.	Tank No. 2.	Tank No. 3.	Res.	Tank No. 1.	Tank No. 2.	Tank No. 3.					
1885, June 24.....	5 P.M....	70.3	70.0	70.0	70.3	.....	.....	.....	79.0	59.5	0.412	41.0	.....
	6	70.2	69.8	69.8	70.2	0.011	0.010	0.005	75.5	56.5	0.459	52.0	5.8
	7	70.0	69.8	69.8	70.0	0.006	0.009	0.005	67.2	56.0	0.464	71.0	2.3
	8	70.0	69.3	69.3	69.4	0.006	0.010	0.005	63.9	54.0	0.420	71.0	2.6
	9	70.0	69.6	69.4	69.4	0.006	0.009	0.009	63.5	54.0	0.409	70.0	3.4
June 25.....	10	69.8	69.9	69.4	69.4	0.013	0.030	0.030	61.5	54.5	0.420	77.0	4.5
	11	69.8	69.1	69.1	69.1	0.013	0.010	0.010	60.0	53.0	0.396	76.0	6.0
	12	69.1	68.4	69.1	68.4	0.014	0.010	0.010	58.0	52.5	0.401	81.0	8.1
	1 A.M....	69.4	68.7	68.7	68.7	0.011	0.030	0.030	58.0	52.0	0.393	82.0	8.1
	2	69.4	68.4	68.4	68.4	0.012	0.009	0.009	56.0	52.0	0.391	87.0	8.8
	3	68.7	68.7	68.7	68.7	0.014	0.009	0.009	55.0	51.0	0.375	87.0	5.3
	4	68.7	68.7	68.7	68.7	0.008	0.020	0.020	54.0	50.0	0.369	87.0	3.7
	5	68.9	68.9	68.9	68.9	0.008	0.020	0.020	57.5	51.5	0.386	81.0	7.9
	6	68.9	68.0	68.7	68.2	0.009	0.020	0.010	63.0	54.0	0.418	72.0	6.8
	7	68.1	68.2	68.7	68.5	0.008	0.010	0.010	69.0	54.0	0.446	63.0	5.9
	8	69.6	69.1	68.5	68.5	0.009	0.030	0.025	72.8	55.0	0.438	54.0	6.4
	9	70.6	69.4	70.0	70.0	0.009	0.010	0.015	76.4	55.5	0.444	49.0	8.4
	10	70.6	71.4	71.4	71.4	0.017	0.010	0.015	80.1	54.0	0.431	41.0	7.0
	11	70.5	72.6	72.0	72.0	0.016	0.010	0.010	82.1	49.0	0.361	33.0	11.2
	12	70.5	73.2	72.9	72.9	0.017	0.010	0.025	85.0	56.0	0.445	37.0	12.7
E.M....	1	71.8	73.8	72.3	72.3	0.010	0.020	0.035	89.0	56.0	0.438	36.0	9.0
	2	72.0	74.3	72.9	72.9	0.010	0.010	0.030	90.0	54.0	0.429	34.0	10.6
	3	72.5	74.5	72.7	72.7	0.010	0.020	0.025	87.0	57.0	0.467	36.0	9.9
	4	72.1	74.1	72.3	72.3	0.020	0.030	0.010	86.1	56.0	0.457	36.0	9.2
	5	72.0	73.6	72.0	72.0	0.015	0.010	0.025	84.0	56.0	0.437	38.0	9.7
Total.....		1757.7	1755.8	1750.5	1757.7	0.270	0.320	0.320	1766.1	1346.0	10.467	1492.0	173.2
Mean		70.1	70.2	70.0	70.1	0.0113	0.0133	0.0133	70.2	53.8	0.419	60.5	7.2
Means (Night.....)		69.6	69.1	69.1	69.1	0.0101	0.0108	0.0108	61.8	53.0	0.408	75.2	5.6
Means (Day.....)		71.5	71.2	70.8	71.2	0.0134	0.0158	0.0158	78.5	55.6	0.431	43.9	8.8

TABLE No. 3.—(Continued.)
HOURLY OBSERVATIONS JULY 8-9, 1885.

DATE.	TIME.	TEMPERATURE AT SURFACE, FAHR.						EVAPORATION, INCHES.						Temp. of Air.	Dew Point.	Force of Vapor.	Relative Humidity.	Miles per Hour.	WIND.
		Roseport.	Tank No. 1.	Tank No. 2.	Tank No. 3.	Tank No. 5.	Tank No. 6.	Tank No. 1.	Tank No. 2.	Tank No. 3.	Tank No. 5.	Tank No. 6.	Tank No. 7.						
July 8.....	5 P.M.....	81.9	83.1	82.4	82.0	82.9	82.4	.....	.....	.....	.....	.....	.....	78.5	72.0	168.3	58.9	.....	S.W.
	6.....	81.9	82.2	81.9	81.7	81.7	81.7	82.0	0.002	0.019	0.010	0.010	0.010	78.0	75.0	168.3	58.9	1.5	S.
	7.....	81.9	81.5	81.1	81.1	80.8	80.8	80.8	0.006	0.010	0.010	0.010	0.010	74.0	71.0	168.3	58.9	1.8	S.
	8.....	81.1	80.4	80.4	80.2	79.7	79.7	79.7	0.004	0.010	0.010	0.010	0.010	73.5	68.0	168.3	58.9	3.2	"
	9.....	80.8	79.7	80.4	80.2	78.8	78.8	78.8	0.010	0.010	0.010	0.010	0.010	70.5	67.0	168.3	58.9	3.2	"
	10.....	80.2	78.8	79.7	79.3	78.1	78.1	78.1	0.010	0.025	0.025	0.025	0.025	70.0	63.0	168.3	58.9	4.2	"
	11.....	79.7	78.3	79.7	79.3	77.7	77.7	77.7	0.010	0.005	0.015	0.015	0.015	66.5	67.0	168.3	58.9	3.7	"
	12.....	79.0	77.7	79.3	79.3	77.2	77.2	77.2	0.010	0.020	0.020	0.020	0.020	66.5	65.0	168.3	58.9	3.7	"
	1 A.M.....	78.6	77.0	78.8	78.3	76.3	76.3	76.3	0.010	0.020	0.025	0.010	0.015	63.0	64.0	168.3	58.9	5.0	"
	2.....	78.3	76.8	78.3	77.7	76.1	76.1	76.1	0.015	0.015	0.025	0.010	0.015	63.0	65.0	168.3	58.9	5.0	"
	3.....	77.9	76.6	78.1	77.7	75.9	75.9	75.9	0.015	0.015	0.020	0.015	0.015	63.0	65.0	168.3	58.9	5.0	"
	4.....	77.7	76.5	77.7	77.2	75.4	75.4	75.4	0.015	0.015	0.020	0.015	0.015	66.5	66.0	168.3	58.9	5.0	"
July 9.....	5.....	77.4	76.3	77.5	76.8	75.1	75.1	75.1	0.004	0.015	0.020	0.015	0.015	66.5	66.0	168.3	58.9	5.9	"
	6.....	77.2	76.3	77.4	76.8	75.1	75.1	75.1	0.011	0.020	0.010	0.010	0.010	72.5	68.0	168.3	58.9	6.0	"
	7.....	77.2	76.6	77.7	77.4	77.3	77.3	77.3	0.010	0.010	0.020	0.010	0.010	72.5	69.0	168.3	58.9	7.1	"
	8.....	77.2	76.6	77.7	77.4	77.3	77.3	77.3	0.010	0.009	0.020	0.010	0.010	80.5	72.0	168.3	58.9	6.4	"
	9.....	78.1	78.3	79.0	78.8	78.9	78.9	78.9	0.010	0.009	0.020	0.010	0.010	83.5	74.0	168.3	58.9	5.7	"
	10.....	79.5	80.2	80.8	80.6	82.0	82.0	82.0	0.003	0.020	0.020	0.010	0.010	88.0	72.0	168.3	58.9	6.8	"
	11.....	80.8	83.1	83.1	81.9	82.9	82.9	82.9	0.003	0.020	0.020	0.010	0.010	90.0	74.0	168.3	58.9	6.8	"
	12.....	80.2	83.5	82.9	81.9	82.9	82.9	82.9	0.002	0.004	0.020	0.010	0.010	90.5	71.0	168.3	58.9	7.5	"
	1 P.M.....	81.0	83.5	83.1	82.0	82.9	82.9	82.9	0.010	0.010	0.020	0.010	0.010	90.5	73.0	168.3	58.9	9.0 S.W.	"
	2.....	81.0	83.5	83.1	82.0	82.9	82.9	82.9	0.015	0.010	0.020	0.010	0.010	89.7	72.0	168.3	58.9	12.9	"
	3.....	79.3	82.6	82.0	81.5	80.8	80.8	80.8	0.020	0.020	0.020	0.010	0.010	89.0	72.0	168.3	58.9	11.6	"
	4.....	80.4	82.2	81.1	80.8	80.8	80.8	80.8	0.010	0.020	0.020	0.010	0.010	87.0	72.0	168.3	58.9	8.7	W.
	5.....	80.6	81.7	80.6	80.4	80.1	80.1	80.1	0.020	0.004	0.010	0.010	0.010	85.0	65.0	168.3	58.9	12.3	"
Total.....		1080.7	1082.3	2005.7	1993.0	1982.7	1980.6	0.242	0.320	0.320	0.290	0.315	0.315	1917.2	1777.0	17.890	1849.5	148.3	
Means.....		79.5	79.6	80.2	79.6	78.2	78.3	0.010	0.013	0.013	0.013	0.013	0.013	77.8	69.1	0.715	74.4	6.2	
Means {	Night.....	79.3	78.9	79.7	79.4	78.1	78.2	0.0092	0.0130	0.0125	0.0117	0.0117	0.0117	71.2	67.0	0.663	68.3	4.0	
	Day.....	79.2	80.3	80.6	79.8	80.3	80.3	0.0109	0.0130	0.0141	0.0125	0.0146	0.0146	84.3	71.2	0.761	69.5	8.3	

TABLE No. 3.—(Continued.)
HOURLY OBSERVATIONS JULY 9-10, 1885.

DATE.	TIME.	TEMPERATURE AT SURFACE, FAHR.						EVAPORATION, INCHES.						Dew Point.	Force of Vapor. Inches.	Relative Humidity. Percent.	Miles per Hour.	WIND. Direction.
		Reservoir.	Tank No. 1.	Tank No. 2.	Tank No. 3.	Tank No. 5.	Tank No. 6.	Tank No. 1.	Tank No. 2.	Tank No. 3.	Tank No. 5.	Tank No. 6.						
July 9.	5 P.M.	80.6	81.7	80.6	80.4	80.1	80.2	.....	.....	.....	.....	.....	.....	75.0	0.028	72.0	12.4	S. W.
	6	79.0	79.3	79.0	78.8	77.9	77.0	0.000	0.000	0.000	0.000	0.000	.....	69.0	0.375	64.0	6.3	"
	7	78.8	78.8	78.8	78.4	77.0	77.0	0.000	0.000	0.000	0.000	0.000	.....	68.0	0.648	95.0	4.9	"
	8	78.6	78.3	78.6	78.1	76.6	76.6	0.010	0.000	0.000	0.000	0.000	.....	67.5	0.648	95.0	4.9	"
	9	78.6	78.3	78.6	78.1	76.6	76.6	0.010	0.000	0.000	0.000	0.000	.....	69.5	0.665	92.0	4.1	"
	10	78.4	78.1	77.9	77.9	76.3	76.5	0.010	0.010	0.010	0.010	0.010	.....	70.0	0.658	90.0	4.5	"
	11	78.4	77.7	78.3	77.7	76.3	76.3	0.015	0.010	0.010	0.010	0.010	.....	71.0	0.680	88.0	5.2	W.
	12	78.3	77.7	78.1	77.5	76.5	76.5	0.010	0.030	0.010	0.010	0.030	.....	71.5	0.675	87.0	6.7	"
	1 A.M.	77.9	77.4	77.9	77.4	76.1	76.3	0.005	0.000	0.010	0.000	0.000	.....	70.0	0.660	90.0	2.7	"
	2	77.7	77.2	77.7	77.0	75.6	75.6	0.015	0.010	0.010	0.010	0.010	.....	70.0	0.622	85.0	2.5	S. W.
	3	77.5	77.0	77.5	76.8	75.7	75.6	0.005	0.010	0.020	0.000	0.000	.....	70.5	0.622	85.0	4.7	"
	4	77.5	76.8	77.4	76.6	75.7	75.7	0.010	0.010	0.020	0.010	0.010	.....	70.0	0.622	85.0	4.2	"
July 10.	5	77.2	76.6	77.0	76.6	75.4	75.4	0.005	0.020	0.010	0.020	0.010	.....	70.5	0.660	85.0	6.3	"
	6	76.8	76.3	76.8	76.5	75.4	75.4	0.014	0.010	0.010	0.010	0.010	.....	71.0	0.660	85.0	6.4	"
	7	76.8	76.5	76.8	76.5	75.3	75.3	0.006	0.010	0.000	0.000	0.000	.....	73.0	0.680	81.0	6.2	"
	8	77.0	76.5	77.0	76.8	76.6	76.6	0.004	0.020	0.020	0.020	0.010	.....	77.5	0.700	72.0	7.2	"
	9	77.2	77.0	77.9	77.5	77.9	77.9	0.011	0.020	0.015	0.025	0.030	.....	79.5	0.887	76.7	11.4	W.
	10	77.5	77.4	78.3	77.9	78.3	77.9	0.020	0.020	0.025	0.015	0.015	.....	79.5	0.650	64.0	12.0	"
	11	77.5	77.4	77.9	77.9	77.7	77.7	0.010	0.010	0.015	0.020	0.025	.....	79.0	0.612	62.0	16.7	"
	12	77.5	77.4	77.7	77.7	77.7	77.7	0.010	0.015	0.015	0.015	0.015	.....	79.5	0.677	66.0	13.5	"
	1 P.M.	77.5	77.9	79.0	78.4	79.0	78.4	0.010	0.010	0.010	0.010	0.015	.....	82.0	0.677	60.0	9.6	"
	2	78.1	79.0	79.7	79.0	79.9	79.9	0.000	0.005	0.010	0.010	0.010	.....	84.0	0.720	58.0	10.3	"
	3	78.6	79.2	79.3	79.0	79.3	79.3	0.035	0.030	0.040	0.035	0.040	.....	83.0	0.610	51.0	13.4	"
	4	78.4	79.0	79.0	78.6	78.4	78.3	0.010	0.020	0.020	0.015	0.015	.....	82.5	0.577	48.0	11.2	N. W.
5	78.3	78.8	78.3	78.3	77.5	77.7	0.025	0.020	0.010	0.030	0.025	.....	80.0	0.585	55.0	8.9	W.	
Total		1949.9	1947.4	1955.8	1945.6	1938.4	1938.4	0.255	0.320	0.310	0.320	0.300	.....	1863.0	16.382	1891.7	191.1	
Mean		77.9	77.8	78.2	77.7	77.1	77.1	0.0106	0.0133	0.0130	0.0133	0.0125	.....	74.4	0.657	76.2	8.0	
Means		{ Night.	78.3	77.9	78.4	77.7	76.4	0.0083	0.0100	0.0100	0.0083	0.0083	.....	70.0	0.643	86.2	5.4	
			77.5	77.6	78.1	77.7	77.7	0.0130	0.0156	0.0158	0.0133	0.0166	.....	78.8	0.672	61.1	10.6	

July 9th, at 4.30 p.m., sun obscured and thunder suddenly heard; at 5.15 p.m. a very heavy storm struck the reservoir, with violent wind, thunder and lightning, and rain, but at 6 p.m. passed over and cleared.

TABLE No. 3.—(Continued.)
HOURLY OBSERVATIONS JULY 10-11, 1885.

DATE.	TIME.	TEMPERATURE AT SURFACE, FAHR.						EVAPORATION, INCHES.						Temperature of Air.	Dew Point.	Force of Vapor. Inches.	Relative Humidity. per cent.	Miles per Hour.	WIND. Direction.
		Tank No. 1.	Tank No. 2.	Tank No. 3.	Tank No. 4.	Tank No. 5.	Tank No. 6.	Tank No. 1.	Tank No. 2.	Tank No. 3.	Tank No. 4.	Tank No. 5.	Tank No. 6.						
July 10.....	5 P.M.	78.3	78.3	78.3	77.9	77.5	77.5	77.6	77.6	77.6	77.6	77.6	77.6	80	63.0	0.585	55.0	7.3	W.
	6	78.3	78.1	77.9	77.9	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	76.0	63.0	0.608	66.6	7.3	W.
	7	77.9	78.1	77.9	77.9	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	71.5	64.0	0.566	73.3	11.0	N.W.
	8	77.9	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	77.5	68.9	62.0	0.564	79.6	7.3	N.W.
	9	77.7	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	77.4	67.0	63.0	0.549	81.7	7.1	W.N.W.
	10	77.5	77.0	77.0	76.5	74.8	74.8	75.0	74.8	75.0	74.8	74.8	74.8	65.5	63.0	0.539	89.0	8.1	W.N.W.
	11	77.4	76.8	77.0	76.6	74.7	74.7	74.8	74.7	74.8	74.7	74.7	74.7	64.0	60.0	0.549	89.0	8.1	N.W.
	12	77.0	76.3	77.0	76.3	74.5	74.5	74.5	74.5	74.5	74.5	74.5	74.5	62.5	61.0	0.517	91.3	6.6	N.W.
	1 A.M.	76.8	76.3	76.6	75.6	74.1	74.1	74.3	74.0	74.0	74.0	74.0	74.0	63.0	60.0	0.510	88.6	3.8	W.
	2	76.6	76.1	76.5	75.7	73.8	73.8	74.1	73.8	73.8	73.8	73.8	73.8	63.0	60.0	0.503	85.9	6.0	N.W.
	3	76.3	75.9	76.3	75.6	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	62.4	60.0	0.517	91.3	7.3	N.W.
	4	76.1	75.6	76.1	75.4	73.8	73.8	73.8	73.8	73.8	73.8	73.8	73.8	61.5	58.0	0.491	88.4	7.0	N.W.
July 11.....	5	75.1	75.4	76.1	75.0	73.6	73.6	73.6	73.6	73.6	73.6	73.6	73.6	63.0	60.0	0.503	85.9	6.5	"
	6	75.7	75.0	76.9	75.2	73.9	73.9	74.3	74.0	74.0	74.0	74.0	74.0	63.0	60.0	0.536	89.8	6.2	"
	7	75.7	75.4	75.7	75.7	74.7	74.7	75.0	74.7	75.0	74.7	74.7	74.7	72.0	62.0	0.580	75.1	8.1	N.W.
	8	76.3	75.6	76.3	76.1	75.9	75.9	75.9	75.9	75.9	75.9	75.9	75.9	72.5	61.0	0.545	67.2	8.0	N.W.
	9	76.6	75.9	77.0	76.6	77.2	77.2	77.4	77.0	77.4	77.0	77.0	77.0	75.0	63.0	0.542	60.3	7.3	"
	10	77.0	76.6	78.1	77.4	78.1	78.1	78.4	78.0	78.1	78.0	78.0	78.0	76.5	63.0	0.557	59.1	8.3	"
	11	77.4	77.1	79.5	78.6	80.2	80.2	80.2	80.2	80.2	80.2	80.2	80.2	78.5	63.0	0.567	56.4	4.6	"
	12	78.3	79.0	79.7	79.0	79.7	79.7	79.7	79.7	79.7	79.7	79.7	79.7	77.0	64.0	0.595	63.0	5.3	N.
	1 P.M.	79.2	79.7	80.4	80.1	79.9	80.6	80.8	80.4	80.8	80.4	80.4	80.4	75.0	64.0	0.592	56.9	6.8	N.
	2	79.2	80.4	81.0	80.6	81.0	81.0	81.0	81.0	81.0	81.0	81.0	81.0	75.0	64.0	0.598	58.5	7.0	N.W.
	3	79.7	80.9	80.1	79.7	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	76.5	63.0	0.574	58.0	6.4	"
	4	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	79.9	77.5	60.0	0.510	53.0	0.2	"
	5	79.5	79.5	79.5	79.5	78.4	78.4	78.4	78.4	78.4	78.4	78.4	78.4	73.0	60.0	0.530	66.5	8.0	N.E.
Total.....		1988.5	1934.1	1946.3	1930.2	1912.4	1915.5	0.289	0.316	0.290	0.300	0.290	0.290	1770.8	1546.0	13.797	1822.2	164.3	
Mean.....		77.5	77.3	77.8	77.1	76.4	76.5	0.0117	0.0120	0.0125	0.0121	0.0121	0.0121	70.6	61.8	0.547	73.4	6.8	
Means (Night.....)		77.2	77.1	76.4	74.9	74.9	74.9	0.0125	0.0158	0.0139	0.0117	0.0108	0.0108	66.4	61.3	0.597	82.9	6.8	
Mean (Day.....)		77.7	77.9	78.5	78.0	78.2	78.2	0.0108	0.0100	0.0117	0.0133	0.0133	0.0133	74.8	62.4	0.508	63.9	6.8	

TABLE No. 3.—(Continued.)
HOURLY OBSERVATIONS AUGUST 7-8, 1885.

DATE.	TIME.	TEMPERATURE AT SURFACE, FAHR.							EVAPORATION, INCHES.							Temp. of Air.	Dew Point.	Force of Vapor. Inches.	Relative Humidity. Per cent.	Miles per Hour.	WIND. Directions.
		Reservoir.	Tank No. 1.	Tank No. 2.	Tank No. 3.	Tank No. 4.	Tank No. 5.	Tank No. 7.	Tank No. 1.	Tank No. 2.	Tank No. 3.	Tank No. 4.	Tank No. 5.	Tank No. 7.							
1885. Aug. 7.	6 P.M.	75.2	75.6	75.0	74.8	74.8	72.8	72.8	72.8	72.8	0.010	0.010	0.010	0.010	0.005	65.0	60.0	0.320	81.3	2.9	S. E.
	7	75.5	75.2	75.0	74.6	74.7	73.0	72.8	72.8	73.1	0.020	0.020	0.015	0.010	0.005	64.9	60.0	0.532	86.3	3.1	"
	8	75.5	74.8	75.0	74.7	74.7	73.1	72.6	72.6	73.0	0.010	0.005	0.000	0.005	0.005	64.8	60.0	0.515	83.6	3.4	"
	9	75.3	74.4	75.0	74.5	74.6	73.0	72.7	72.7	73.0	0.010	0.005	0.000	0.005	0.005	64.5	61.5	0.553	92.6	2.0	E.
	10	75.1	74.4	74.9	74.5	74.5	73.2	72.7	72.7	73.1	0.005	0.010	0.015	0.015	0.010	64.0	61.5	0.546	91.6	1.3	"
	11	75.1	74.2	74.9	74.5	74.5	73.1	72.8	72.8	73.1	0.005	0.010	0.010	0.005	0.010	63.3	60.5	0.520	88.7	1.2	"
	12	74.9	74.1	74.9	74.4	74.4	73.2	72.8	72.8	73.1	0.005	0.010	0.010	0.005	0.010	62.2	62.0	0.554	99.4	0.5	"
	1 A.M.	74.8	74.0	74.7	74.2	74.2	73.2	72.8	72.8	73.1	0.010	0.010	0.000	0.000	0.000	63.0	63.0	0.576	100.0	1.8	"
	2	74.7	73.8	74.6	74.0	74.2	72.8	72.2	72.2	73.0	0.010	0.005	0.000	0.000	0.000	62.0	60.0	0.523	94.2	2.0	S. E.
	3	74.6	73.8	74.4	73.8	74.0	72.4	72.2	72.2	73.0	0.010	0.005	0.010	0.010	0.010	60.5	60.5	0.528	100.0	2.0	N. W.
	4	74.4	73.8	74.4	73.6	73.2	71.8	71.8	71.8	73.0	0.010	0.015	0.000	0.010	0.010	60.7	60.7	0.531	100.0	2.0	"
	5	74.0	73.6	74.0	73.6	73.2	72.0	72.0	72.0	73.1	0.010	0.010	0.015	0.010	0.010	66.8	64.5	0.600	91.9	2.0	N. E.
6	74.3	73.6	74.3	73.9	74.0	73.1	72.0	72.0	73.1	0.000	0.010	0.005	0.010	0.010	77.5	64.5	0.699	70.2	4.5	E.	
7	74.6	73.8	74.2	74.2	74.4	73.8	74.0	74.0	75.0	0.005	0.010	0.020	0.020	0.025	78.5	66.0	0.619	63.5	5.2	"	
8	74.8	74.4	75.0	74.8	75.0	75.0	75.0	75.0	75.0	0.005	0.010	0.020	0.020	0.025	75.8	59.0	0.595	56.3	8.2	"	
9	75.0	74.5	75.4	75.4	75.4	75.4	75.4	75.4	75.4	0.010	0.015	0.020	0.020	0.025	80.0	60.0	0.524	51.2	8.8	"	
10	75.2	75.0	76.1	75.6	75.8	76.2	75.8	75.8	76.2	0.015	0.015	0.020	0.020	0.025	77.0	59.5	0.500	55.0	6.2	"	
11	75.5	76.0	77.0	76.2	76.4	77.3	77.1	77.1	77.1	0.015	0.020	0.020	0.020	0.025	77.0	56.0	0.457	49.3	6.3	"	
12	75.8	76.6	77.2	76.4	76.6	77.4	77.2	77.2	77.2	0.015	0.020	0.020	0.020	0.025	77.5	57.0	0.497	49.6	7.7	"	
1 P.M.	76.0	76.8	76.7	76.4	76.4	76.7	76.5	76.5	76.5	0.020	0.020	0.040	0.035	0.025	76.8	60.0	0.510	55.0	8.1	"	
2	76.0	76.9	76.3	76.2	76.2	75.9	75.7	75.7	75.7	0.010	0.010	0.015	0.000	0.010	76.8	61.0	0.534	58.6	7.2	"	
3	75.0	76.7	75.8	75.8	75.0	75.0	75.0	75.0	75.0	0.015	0.020	0.020	0.025	0.030	74.8	62.0	0.550	63.8	4.4	"	
4	75.8	76.4	75.8	75.6	74.4	74.4	74.1	74.1	74.1	0.010	0.015	0.015	0.005	0.020	74.8	62.0	0.550	63.8	4.4	"	
5	75.7	76.1	75.6	75.2	75.3	73.8	73.2	73.2	73.2	0.020	0.010	0.000	0.010	0.005	74.8	62.0	0.554	63.9	3.2	"	
6	1877.8	1872.1	1880.3	1870.6	1872.1	1849.7	1843.6	1843.6	1843.6	0.285	0.260	0.260	0.260	0.260	1733.2	1524.2	13.199	1929.6	95.0		
Total.		75.1	74.8	75.2	74.8	74.9	72.8	72.8	72.8	73.0	0.019	0.018	0.018	0.018	0.018	69.3	61.0	0.532	77.4	4.0	
Mean		74.9	74.2	74.7	74.2	74.2	72.8	72.5	72.5	72.5	0.014	0.0075	0.0071	0.0066	0.0058	63.3	61.0	0.529	92.6	2.0	
Means	{ Night..... { Day.....	75.3	75.4	75.7	75.4	75.5	75.3	75.0	75.0	75.0	0.0134	0.0142	0.0140	0.0150	0.0158	75.3	60.9	0.535	62.2	6.0	

TABLE No. 3. — (Continued.)
HOURLY OBSERVATIONS.—SEPTEMBER 11-12, 1885.

DATE.	TIME.	TEMPERATURE AT SURFACE, FAHR.							EVAPORATION, INCHES.							Temp. of Air.	Dew Point.	Force of Vapor. Inches.	Relative Humidity. Per cent.	WIND.	
		Therm. No. 1.	Therm. No. 2.	Therm. No. 3.	Therm. No. 4.	Therm. No. 5.	Therm. No. 7.	Therm. No. 1.	Therm. No. 2.	Therm. No. 3.	Therm. No. 4.	Therm. No. 5.	Therm. No. 7.	Miles per Hour.	Direction.						
1885. Sept. 11.....	6 P. M.	66.1	65.7	65.8	65.4	65.4	63.6	63.1	63.1	63.1	63.1	63.1	63.1	0.005	0.005	50.0	0.370	83.9	S. E.	2.5	.....
	7	65.9	65.0	65.6	64.7	64.7	62.8	62.0	62.0	62.0	62.0	62.0	62.0	0.010	0.010	47.1	0.321	85.9	"	3.0	.....
	8	65.5	64.6	65.2	64.5	64.5	62.5	61.3	61.3	61.3	61.3	61.3	61.3	0.005	0.005	46.0	0.304	88.9	S. W.	1.6	.....
	9	65.3	64.4	65.2	64.5	64.5	62.3	61.2	61.2	61.2	61.2	61.2	61.2	0.010	0.010	47.0	0.323	96.2	"	1.3	.....
	10	65.4	64.2	65.1	64.5	64.5	61.6	60.2	60.2	60.2	60.2	60.2	60.2	0.006	0.006	45.5	0.304	92.4	"	4.4	.....
	11	65.3	63.7	64.8	64.0	64.0	61.4	60.1	60.1	60.1	60.1	60.1	60.1	0.010	0.010	47.5	0.341	96.3	"	4.1	.....
	12	65.2	63.8	64.8	63.8	63.8	61.4	60.2	60.2	60.2	60.2	60.2	60.2	0.010	0.010	46.0	0.311	100.0	"	3.6	.....
	1 A. M.</td <td>65.0</td> <td>63.6</td> <td>64.8</td> <td>63.8</td> <td>63.8</td> <td>61.4</td> <td>60.2</td> <td>60.2</td> <td>60.2</td> <td>60.2</td> <td>60.2</td> <td>60.2</td> <td>0.010</td> <td>0.010</td> <td>45.0</td> <td>0.299</td> <td>100.0</td> <td>"</td> <td>2.2</td> <td>.....</td>	65.0	63.6	64.8	63.8	63.8	61.4	60.2	60.2	60.2	60.2	60.2	60.2	0.010	0.010	45.0	0.299	100.0	"	2.2	
	2	65.0	63.4	64.8	63.8	63.8	61.4	60.2	60.2	60.2	60.2	60.2	60.2	0.010	0.010	44.0	0.288	100.0	"	2.6	.....
Sept. 12.....	3	64.8	63.4	64.6	63.8	63.8	61.2	59.8	59.8	59.8	59.8	59.8	59.8	0.010	0.010	43.5	0.283	100.0	"	2.4	.....
	4	64.8	63.2	64.4	63.4	63.4	61.0	59.8	59.8	59.8	59.8	59.8	59.8	0.010	0.010	45.0	0.275	92.0	"	2.2	.....
	5	64.8	63.0	64.5	63.6	63.6	61.2	59.8	59.8	59.8	59.8	59.8	59.8	0.015	0.015	47.0	0.323	100.0	"	3.0	.....
	6	64.8	63.0	64.6	63.8	63.9	62.0	60.8	60.8	60.8	60.8	60.8	60.8	0.005	0.005	52.1	0.407	87.4	"	3.5	.....
	7	64.6	63.4	64.6	64.1	64.1	63.4	62.0	62.0	62.0	62.0	62.0	62.0	0.010	0.010	53.0	0.407	87.4	S. W.	5.3	.....
	8	65.3	61.1	65.2	65.1	66.3	66.7	65.2	65.2	65.2	65.2	65.2	65.2	0.009	0.009	66.0	0.454	71.4	"	1.8	.....
	9	67.2	66.0	68.8	68.5	67.5	68.6	69.2	69.2	69.2	69.2	69.2	69.2	0.010	0.010	66.0	0.454	48.8	N. E.	1.1	.....
	10	68.1	68.2	70.8	69.6	70.2	70.6	72.4	72.4	72.4	72.4	72.4	72.4	0.010	0.010	82.0	0.400	42.2	"	0.0	.....
	11	68.4	68.2	70.8	69.6	70.2	70.6	72.4	72.4	72.4	72.4	72.4	72.4	0.010	0.010	80.0	0.427	44.5	N. E.	1.3	.....
Sept. 12.....	12	70.2	69.6	72.2	71.0	71.8	72.1	74.0	74.0	74.0	74.0	74.0	74.0	0.010	0.010	80.0	0.487	47.6	N. W.	2.9	.....
	1 P. M.</td <td>69.4</td> <td>70.4</td> <td>72.3</td> <td>71.0</td> <td>71.8</td> <td>72.0</td> <td>75.0</td> <td>75.0</td> <td>75.0</td> <td>75.0</td> <td>75.0</td> <td>75.0</td> <td>0.015</td> <td>0.015</td> <td>80.0</td> <td>0.487</td> <td>47.6</td> <td>N. W.</td> <td>2.9</td> <td>.....</td>	69.4	70.4	72.3	71.0	71.8	72.0	75.0	75.0	75.0	75.0	75.0	75.0	0.015	0.015	80.0	0.487	47.6	N. W.	2.9	
	2	70.0	70.8	72.2	71.0	71.8	72.0	74.0	74.0	74.0	74.0	74.0	74.0	0.015	0.015	79.0	0.431	43.4	S. W.	2.8	.....
	3	70.0	70.6	71.4	70.5	71.0	71.2	73.0	73.0	73.0	73.0	73.0	73.0	0.015	0.015	77.0	0.459	50.6	S. W.	3.3	.....
	4	70.4	69.9	70.5	70.0	70.5	70.0	71.8	71.8	71.8	71.8	71.8	71.8	0.010	0.010	67.0	0.470	71.5	"	4.2	.....
	5	69.7	69.0	69.4	69.4	69.4	68.2	69.2	69.2	69.2	69.2	69.2	69.2	0.010	0.010	63.0	0.439	74.9	S. E.	2.8	.....
Total.....	1697.5	1645.0	1676.4	1657.8	1661.8	1625.2	1619.0	1620.0	1620.0	1620.0	1620.0	1620.0	1620.0	0.175	0.175	1477.2	1280.5	9.200	1295.8	65.9	.....
	Mean.....	66.6	65.7	67.0	66.3	66.4	65.1	65.0	65.0	65.0	65.0	65.0	65.0	0.0073	0.0073	59.1	0.366	76.9	.....	2.7	.....
Means {	Night.....	65.2	63.9	64.9	64.2	64.2	61.8	60.7	60.683	60.692	60.680	60.675	60.682	0.0072	0.0072	47.9	0.310	94.1	.....	2.7	.....
	Day.....	68.1	67.6	69.1	68.4	68.7	68.4	69.3	69.3	69.3	69.3	69.3	69.3	0.0096	0.0096	70.9	0.423	59.7	.....	2.7	.....

TABLE No. 3.—(Continued.)
HOURLY OBSERVATIONS.—OCTOBER 14-15, 1885.

DATE.		TIME.	TEMPERATURE AT SURFACE, FAHR.							EVAPORATION, INCHES.							Temp. of Air.	Dew Point.	Force of Vapor.	Inches.	Relative Humidity.	Miles per Hour.	WIND.
			Reservoir.	Tank No. 1.	Tank No. 2.	Tank No. 3.	Tank No. 4.	Tank No. 5.	Tank No. 7.	Tank No. 1.	Tank No. 2.	Tank No. 3.	Tank No. 4.	Tank No. 5.	Tank No. 7.								
1885. Oct. 14.	5 P.M.	56.0	57.4	57.0	56.4	56.6	56.8	58.0	0.002	0.010	0.000	0.005	0.010	0.005	55.0	53.0	0.400	96.1	8.1	S.			
	6	55.8	57.0	56.8	55.8	55.4	55.4	56.0	0.002	0.010	0.000	0.005	0.010	0.005	53.0	50.0	0.361	93.4	7.7	"			
	7	55.6	56.6	56.8	55.6	55.6	54.4	54.8	0.000	0.010	0.005	0.005	0.000	0.010	50.0	47.0	0.331	89.1	8.4	S.W.			
	8	55.6	56.0	56.4	55.3	55.3	53.6	53.8	0.008	0.010	0.005	0.015	0.000	0.010	49.0	47.0	0.322	92.6	8.1	"			
	9	55.5	55.5	55.6	55.2	55.1	54.8	53.1	0.000	0.005	0.010	0.005	0.005	0.005	49.0	46.0	0.327	85.8	6.5	"			
Oct. 15.	10	55.5	55.0	55.4	54.9	54.8	53.0	52.5	0.000	0.015	0.000	0.010	0.010	0.010	48.0	45.0	0.303	88.8	5.5	"			
	11	55.5	54.7	55.3	54.9	54.7	52.9	52.5	0.000	0.005	0.010	0.010	0.010	0.005	47.5	46.5	0.303	88.8	5.0	"			
	12	55.5	54.6	55.3	54.9	54.7	52.7	52.2	0.000	0.005	0.010	0.010	0.010	0.005	47.5	46.5	0.303	88.8	5.0	"			
	1 A.M.	55.4	54.6	55.2	54.8	54.6	52.6	52.0	0.015	0.005	0.010	0.000	0.010	0.005	47.5	45.0	0.297	92.3	6.0	"			
	2	55.4	54.4	55.2	54.6	54.6	52.6	51.6	0.015	0.005	0.010	0.000	0.010	0.005	45.5	44.0	0.293	96.0	7.7	"			
	3	55.4	54.2	55.2	54.6	54.6	52.6	51.8	0.000	0.015	0.000	0.005	0.010	0.015	46.0	46.0	0.310	100.0	7.0	"			
	4	55.4	54.2	55.2	54.6	54.4	52.4	51.8	0.000	0.010	0.000	0.000	0.010	0.000	47.0	46.0	0.310	96.1	6.8	"			
	5	55.2	54.2	55.0	54.6	54.4	52.4	52.2	0.010	0.000	0.010	0.005	0.000	0.005	48.0	47.0	0.322	96.2	7.8	"			
	6	55.2	54.1	55.0	54.6	54.4	52.4	52.2	0.010	0.000	0.010	0.015	0.000	0.005	48.0	47.0	0.322	96.2	7.8	"			
	7	55.2	54.1	55.0	54.6	54.4	52.4	52.7	0.005	0.010	0.010	0.015	0.000	0.005	50.5	48.5	0.310	92.7	7.8	"			
	8	55.2	54.1	55.0	54.6	54.4	52.4	52.7	0.010	0.000	0.010	0.015	0.000	0.005	50.5	48.5	0.310	92.7	7.8	"			
	9	55.3	54.8	55.8	55.4	55.4	55.4	55.7	0.005	0.005	0.005	0.000	0.000	0.020	51.0	50.0	0.376	86.9	9.7	"			
Oct. 15.	10	55.6	56.2	57.0	56.8	57.0	57.0	57.5	0.005	0.005	0.010	0.020	0.010	0.020	51.0	50.0	0.383	72.2	9.7	"			
	11	56.0	56.2	58.4	57.8	58.0	58.4	59.4	0.005	0.000	0.000	0.010	0.010	0.010	52.0	51.0	0.386	71.3	8.1	"			
	12	56.4	56.8	59.2	57.9	58.2	58.4	60.4	0.005	0.005	0.005	0.010	0.010	0.005	53.0	52.0	0.392	69.3	8.1	"			
	1 P.M.	56.2	57.3	57.8	57.2	58.0	58.4	59.4	0.005	0.010	0.015	0.030	0.010	0.020	51.0	50.0	0.354	66.3	7.5	N.W.			
	2	56.0	57.3	57.8	57.2	58.2	58.4	59.4	0.005	0.010	0.025	0.010	0.030	0.010	51.0	50.0	0.354	66.3	7.5	"			
Oct. 15.	3	56.4	56.8	58.8	58.0	57.0	58.8	57.9	0.015	0.010	0.025	0.000	0.040	0.015	53.0	50.0	0.369	88.2	8.8	"			
	4	56.4	56.8	58.8	58.0	57.0	58.8	57.9	0.015	0.010	0.025	0.000	0.040	0.015	53.0	50.0	0.369	88.2	8.8	"			
	5	56.4	56.8	58.8	58.0	57.0	58.8	57.9	0.015	0.010	0.025	0.000	0.040	0.015	53.0	50.0	0.369	88.2	8.8	"			
	6	56.2	56.2	56.2	56.2	56.2	56.2	56.4	0.005	0.020	0.010	0.015	0.010	0.010	57.5	48.5	0.357	73.4	9.8	W.			
	7	56.2	56.2	56.2	56.2	56.2	56.2	56.4	0.005	0.020	0.010	0.015	0.010	0.010	57.5	48.5	0.357	73.4	9.8	W.			
Total		1392.5	1389.2	1402.0	1391.9	1397.0	1369.6	1372.2	0.100	0.140	0.130	0.145	0.140	0.125	1338.8	1211.0	8.403	2005.8	165.2				
	Mean	55.7	55.5	56.0	55.6	55.8	54.7	54.8	0.0042	0.0098	0.0094	0.0060	0.0068	0.0052	53.5	48.3	0.338	83.8	6.9				
Means	Night.....	55.5	55.2	55.4	55.0	55.0	53.4	53.1	0.0042	0.0033	0.0034	0.0042	0.0025	0.0012	49.0	46.9	0.322	92.7	5.3				
	Day.....	55.8	55.8	56.6	56.2	56.0	56.1	56.5	0.0042	0.0058	0.0075	0.0072	0.0091	0.0082	55.0	49.7	0.354	74.8	8.5				

TABLE No. 4.

EFFECTS OF TEMPERATURE ON EVAPORATION.

1	2	3	4	5	6	7	8	9	10
Number of Experiment.	Date.	Duration.	No. of Pan.	Range of Temperature.	Mean Temp. Water Surface.	Max. Force of Vapor for Col. No. 6.	Av. Force of Vapor in the Air.	Difference (V-v).	Evaporation, inches per hour.
	1885.	Hours.		Fahr.	Fahr.	V.	v.		
1	April 18	7	1	36.0	138.4	5.621	0.350	5.271	0.1278
2	18	8	2	17.1	106.9	2.354	0.350	2.004	0.0340
3	18	8	3	7.2	71.9	0.782	0.350	0.432	0.0080
4	20	10	1	11.5	112.6	2.778	0.413	2.365	0.0442
5	20	10	2	7.2	88.0	1.323	0.413	0.910	0.0142
6	20	10	3	6.7	66.4	0.648	0.413	0.235	0.0036
7	20	6	4	12.1	64.0	0.596	0.433	0.163	0.0031
8	21	10	1	13.5	113.5	2.851	0.494	2.357	0.0412
9	21	10	2	5.4	89.2	1.375	0.494	0.881	0.0120
10	21	10	3	11.3	67.3	0.668	0.494	0.174	0.0035
11	21	10	4	15.8	66.7	0.655	0.494	0.161	0.0029
12	22	10	1	9.0	114.3	2.917	0.495	2.422	0.0449
13	22	10	2	16.2	92.1	1.505	0.495	1.010	0.0160
14	22	10	3	7.7	69.6	0.723	0.495	0.228	0.0032
15	22	10	4	8.1	68.5	0.696	0.495	0.201	0.0036
16	23	4	1	7.7	113.9	2.884	0.494	2.390	0.0400
17	23	4	2	3.6	89.8	1.401	0.494	0.907	0.0128
18	23	4	3	7.2	63.9	0.594	0.494	0.100	0.0034
19	23	4	4	9.9	63.0	0.576	0.494	0.082	0.0016
20	23	6	1	10.8	113.4	2.843	0.512	2.331	0.0423
21	23	6	2	9.6	87.6	1.306	0.512	0.794	0.0086
22	23	6	3	7.2	72.1	0.787	0.512	0.275	0.0036
23	23	6	4	8.5	73.0	0.811	0.512	0.299	0.0031
24	24	4	1	3.6	114.3	2.917	0.530	2.387	0.0397
25	24	4	2	5.0	92.1	1.605	0.530	0.975	0.0137
26	24	4	3	9.4	65.9	0.637	0.530	0.107	0.0025
27	24	4	4	4.7	64.9	0.615	0.530	0.085	0.0016
28	24	6	1	9.0	113.4	2.843	0.567	2.276	0.0373
29	24	6	2	2.7	89.4	1.343	0.567	0.816	0.0102
30	24	6	3	6.8	74.5	0.853	0.567	0.286	0.0042
31	24	6	4	6.3	76.3	0.906	0.567	0.339	0.0031
32	May 19	4	1	4.8	134.3	5.049	0.765	4.284	0.0769
33	19	4	2	5.4	119.9	3.416	0.765	2.651	0.0434
34	19	4	3	7.2	97.9	1.800	0.765	1.036	0.0166
35	20	9.5	1	18.5	132.7	4.841	0.499	4.342	0.0849
36	20	9.5	2	8.3	117.7	3.212	0.499	2.713	0.0468
37	20	9.5	3	8.6	98.0	1.805	0.499	1.306	0.0208
38	21	9.5	1	13.5	130.8	4.601	0.506	4.096	0.0787
39	21	9.5	2	7.2	118.1	3.248	0.506	2.742	0.0468
40	21	9.5	3	19.9	98.4	1.827	0.506	1.321	0.0224
41	22	9.5	1	6.3	135.0	5.143	0.557	4.586	0.0841
42	22	9.5	2	9.9	117.3	3.176	0.557	2.619	0.0425
43	22	9.5	3	9.0	98.0	1.805	0.557	1.248	0.0197
44	23	9	1	14.9	117.0	3.149	0.532	2.617	0.0549
45	23	9	2	6.7	134.7	5.103	0.532	4.571	0.0874
46	23	9	3	10.6	98.1	1.811	0.532	1.279	0.0192
47	23	5	1	9.0	117.7	3.212	0.642	2.570	0.0485
48	25	5	2	9.9	134.8	5.116	0.642	4.474	0.0832
49	25	5	3	5.7	96.5	1.725	0.642	1.083	0.0150
50	25	4.5	1	12.2	134.0	5.009	0.762	4.247	0.0911
51	25	4.5	2	8.1	118.5	3.285	0.762	2.523	0.0406
52	26	4.5	3	4.5	97.1	1.766	0.762	0.994	0.0142
53	26	5	1	11.7	128.0	4.372	0.550	3.822	0.0788
54	26	5	2	4.1	115.7	3.036	0.550	2.486	0.0397
55	26	5	3	7.4	96.5	1.725	0.550	1.175	0.0162
56	26	4.5	4	16.0	128.3	4.302	0.504	3.798	0.0719
57	26	4.5	2	9.9	114.8	2.969	0.504	2.455	0.0386

TABLE No. 4—(Continued).
EFFECTS OF TEMPERATURE ON EVAPORATION.

1	2	3	4	5	6	7	8	9	10
Number of Experiment.	Date.	Duration.	No. of Pan.	Range of Temperature.	Mean Temp. Water Surface.	Max. Force of Vapor for Col. No. 6.	Av. Force of Vapor in the Air.	Difference (1-8).	Evaporation, Inches per Hour.
	1885.	Hours.		Fahr.	Fahr.	V.	v.		
58	May 26	4 5	3	10.8	97.7	1.789	0.504	1.285	0.0169
59	27	9.5	1	11.5	99.2	1.872	0.474	1.398	0.0217
60	27	9.5	2	9.0	115.7	3.036	0.474	2.562	0.0406
61	27	9.5	3	11.7	132.4	4.801	0.474	4.327	0.0768
62	28	9.5	1	7.5	134.4	5.063	0.392	4.671	0.0893
63	28	9.5	2	10.8	117.2	3.167	0.392	2.775	0.0479
64	28	9.5	3	13.0	98.9	1.855	0.392	1.463	0.0230
65	29	9.5	1	7.7	125.3	3.966	0.477	3.489	0.0609
66	29	9.5	2	6.1	136.7	5.378	0.477	4.901	0.0888
67	29	9.5	3	14.7	102.1	2.013	0.477	1.566	0.0232
68	June 1	9.5	1	21.4	124.8	3.912	0.599	3.313	0.0628
69	1	9.5	2	14.2	135.7	5.239	0.599	4.640	0.0859
70	1	9.5	3	16.2	101.2	1.989	0.599	1.390	0.0203
71	2	9.5	1	9.2	102.1	2.043	0.385	1.658	0.0297
72	2	9.5	2	7.7	122.7	3.692	0.385	3.307	0.0572
73	2	9.5	3	9.0	136.2	5.308	0.385	4.923	0.0974
74	3	9.5	1	6.7	134.8	5.116	0.676	4.540	0.0897
75	3	9.5	2	3.6	135.5	5.211	0.576	4.635	0.0864
76	3	9.5	3	10.6	119.7	3.397	0.576	2.821	0.0501
77	4	9.5	1	11.7	135.2	5.170	0.674	4.496	0.0866
78	4	9.5	2	9.0	119.0	3.331	0.674	2.657	0.0470
79	4	9.5	3	16.2	102.2	2.049	0.674	1.375	0.0208
80	5	9.5	1	12.6	136.7	5.378	0.457	4.912	0.1050
81	5	9.5	2	9.0	119.4	3.369	0.457	2.912	0.0551
82	5	9.5	3	10.3	100.6	1.959	0.457	1.502	0.0248
83	6	9	1	6.8	137.5	5.491	0.480	5.011	0.1035
84	6	9	2	13.5	123.8	3.805	0.480	3.325	0.0614
85	6	9	3	14.4	102.6	2.080	0.480	1.600	0.0268
86	8	9.5	1	4.9	138.0	5.563	0.776	4.787	0.0929
87	8	9.5	2	16.7	125.9	4.031	0.776	3.255	0.0545
88	8	9.5	3	5.4	102.2	2.049	0.776	1.273	0.0182
89	10	7.5	1	9.2	121.6	3.581	0.455	3.126	0.0650
90	10	7.5	2	12.6	138.4	5.621	0.455	5.166	0.1098
91	10	7.5	3	14.4	102.8	2.087	0.455	1.632	0.0245
92	11	9.5	1	10.3	120.7	3.493	0.620	2.873	0.0555
93	11	9.5	2	14.4	138.9	5.694	0.620	5.074	0.1056
94	11	9.5	3	13.5	102.3	2.056	0.620	1.436	0.0199
95	12	9.5	1	14.9	124.0	3.826	0.704	3.122	0.0575
96	12	9.5	2	17.1	138.8	5.680	0.704	4.976	0.0953
97	12	9.5	3	14.6	103.5	2.150	0.704	1.446	0.0189
98	13	3	1	5.0	125.4	3.977	0.749	3.228	0.0575
99	13	3	2	8.6	156.5	8.852	0.749	8.103	0.1609
100	13	3	3	3.6	101.1	1.983	0.749	1.234	0.0167
101	13	3	1	7.5	122.2	3.652	0.781	2.871	0.0500
102	13	3	2	11.7	144.5	6.574	0.781	5.793	0.1054
103	13	3	3	9.9	104.5	2.195	0.781	1.414	0.0192
104	15	9.5	1	15.3	125.2	3.955	0.762	3.193	0.0546
105	15	9.5	2	10.4	146.9	6.984	0.762	6.222	0.1179
106	15	9.5	3	6.2	102.6	2.074	0.762	1.312	0.0167
107	16	2	1	4.5	102.9	2.093	1.015	1.078	0.0175
108	16	2	2	3.6	144.8	6.624	1.015	5.609	0.1050
109	16	2	3	5.2	100.4	1.942	1.015	0.927	0.0133
110	16	7.5	1	25.0	106.8	2.347	1.074	1.273	0.0188
111	16	7.5	2	11.7	150.0	7.547	1.074	6.473	0.1232
112	16	7.5	3	12.2	106.3	2.313	1.074	1.239	0.0153
113	18	1	1	3.9	105.2	2.240	0.588	1.652	0.0237
114	18	1	2	25.6	142.3	6.215	0.588	5.627	0.1137

TABLE No. 4—(Continued).

EFFECTS OF TEMPERATURE ON EVAPORATION.

1	2	3	4	5	6	7	8	9	10
Number of Experiment.	Date.	Duration.	No. of Fan.	Range of Temperature.	Mean Temp. Water Surface.	Max. Force of Vapor for Col. 6.	Av. Force of Vapor in the Air.	Difference, (7-8).	Evaporation Inches per Hour.
	1885.	Hours.		Fahr.	Fahr.	F.	°.		
115	June 18	1	3	2.7	103.5	2.131	0.588	1.543	0.0237
116	18	4	1	5.0	106.0	2.293	0.670	1.623	0.0281
117	18	4	2	5.4	158.4	9.267	0.670	8.597	0.1781
118	18	4	3	6.8	106.2	2.307	0.670	1.637	0.0244
119	18	4.5	1	4.5	104.8	2.214	0.739	1.475	0.0231
120	18	4.5	2	9.0	144.5	6.574	0.739	5.835	0.1103
121	18	4.5	3	12.6	106.5	2.327	0.739	1.588	0.0233
122	19	4	1	6.3	107.0	2.361	0.747	1.614	0.0259
123	19	4	2	9.9	152.2	7.969	0.747	7.222	0.1406
124	19	4	3	5.4	105.3	2.247	0.747	1.500	0.0222
125	24	2	2	9.0	106.3	2.313	0.644	1.769	0.0312
126	24	2	3	5.4	103.7	2.144	0.644	1.600	0.0218
127	24	3.5	1	9.0	138.8	5.680	0.623	5.057	0.1121
128	24	3.5	2	4.5	105.1	2.300	0.623	1.677	0.0253
129	24	3.5	3	8.1	104.6	2.201	0.623	1.678	0.0233
130	26	4	1	4.8	140.6	5.950	0.895	5.055	0.1038
131	26	4	2	12.6	108.0	2.431	0.895	1.536	0.0222
132	26	4	3	11.0	108.2	2.445	0.895	1.550	0.0240
133	26	5.5	1	13.1	133.7	4.970	0.912	4.058	0.0839
134	26	5.5	2	6.3	104.5	2.195	0.912	1.283	0.0175
135	26	5.5	3	5.7	103.7	2.145	0.912	1.233	0.0166
136	July 15	6.5	1	5.9	130.2	4.527	0.732	3.795	0.0677
137	15	6.5	2	4.1	129.9	4.491	0.732	3.759	0.0629
138	16	9.5	1	9.5	130.4	4.551	0.887	3.664	0.0696
139	16	9.5	2	8.6	130.8	4.601	0.887	3.714	0.0607
140	Aug. 7	8.5	1	5.4	129.2	4.408	0.680	3.728	0.0638
141	7	8.5	2	5.4	129.4	4.431	0.680	3.751	0.0623
142	8	8.0	1	12.6	128.9	4.372	0.752	3.620	0.0744
143	8	8.0	2	6.6	129.5	4.443	0.752	3.691	0.0656
144	Dec. 24	8.5	3	17.4	132.1	4.763	0.415	4.348	0.0992
145	26	6.5	3	16.7	131.2	4.637	0.193	4.444	0.1092
146	29	8.5	3	15.0	127.8	4.244	0.219	4.025	0.0963
147	30	8.5	3	10.8	135.3	5.184	0.460	4.724	0.1003
148	31	6.0	3	20.7	149.2	7.398	0.422	6.976	0.1715
	1886.								
149	Jan. 1	8.0	3	14.7	147.2	7.036	0.241	6.795	0.1602
150	2	8.0	3	19.8	149.2	7.398	0.393	7.065	0.1465
151	4	8.0	3	20.9	147.6	7.108	0.385	6.723	0.1436
152	5	8.0	3	8.8	149.7	7.491	0.496	6.995	0.1528
153	6	8.0	3	17.1	145.8	6.793	0.380	6.463	0.1486
154	7	8.0	3	31.1	159.6	9.538	0.117	9.421	0.2687

TABLE No. 5.

EFFECT OF WIND ON EVAPORATION.

DATE.	Duration.	Mean Temp. Water.	Evaporation, Inches per Hour.	Max. Force of Vapor.	Force of Vapor in Air.	Diff. $V-v$.	$(V-v)^2$.	.0012 $(V-v)^2$.	.014 $(V-v)$.	.014 $(V-v) +$.0012 $(V-v)^2$	Evap. $\div$ by pre- ceding Col. Wind Factor.	Mean Wind. Miles per Hour.
		Fahr.		V.	v.							
1885.												
April 8	9.5	107.6	0.0740	2.403	0.386	2.017	4.0683	.00488	.02824	.03312	2.234	2.6
8	9.5	108.7	0.0698	2.481	0.386	2.095	4.3890	.00527	.02993	.03460	2.017	2.6
8	9.5	110.8	0.0764	2.638	0.386	2.252	5.0715	.00609	.03153	.03762	2.031	2.6
9	3.0	102.6	0.1370	2.074	0.103	1.971	3.8848	.00466	.02750	.03225	4.276	13.8
9	3.5	79.6	0.0539	1.010	0.103	0.907	0.8226	.00099	.01270	.01369	3.937	13.8
9	3.5	63.0	0.0346	0.576	0.103	0.473	0.2237	.00027	.00662	.00689	5.022	13.8
9	2.5	98.4	0.1169	1.827	0.113	1.714	2.9378	.00353	.02400	.02753	4.246	11.62
9	2.5	83.1	0.0660	1.131	0.113	1.018	1.0363	.00124	.01425	.01549	4.261	11.62
9	2.5	67.0	0.0374	0.662	0.113	0.549	0.3014	.00036	.00749	.00805	4.646	11.62
9	2.0	100.0	0.1175	1.918	0.098	1.820	3.3124	.00397	.02548	.02945	3.990	10.25
9	2.0	87.4	0.0656	1.298	0.098	1.200	1.4400	.00173	.01680	.01853	3.540	10.25
9	2.0	69.5	0.0393	0.721	0.098	0.623	0.3881	.00047	.00872	.00919	4.276	10.25
10	9.5	110.3	0.1086	2.600	0.139	2.461	6.0565	.00727	.03445	.04172	2.603	4.2
10	9.5	91.6	0.0578	1.436	0.139	1.297	1.6822	.00202	.01816	.02018	2.864	4.2
10	9.5	71.8	0.0320	0.779	0.139	0.640	0.4096	.00049	.00886	.00945	3.386	4.2
11	3.0	114.6	0.1032	2.942	0.130	2.812	7.9073	.00949	.03937	.04886	2.112	2.4
11	4.0	108.5	0.0965	2.467	0.117	2.350	5.6225	.00663	.03290	.03953	2.441	4.2
11	2.0	107.9	0.0998	2.424	0.118	2.306	5.3176	.00638	.03228	.03866	2.582	5.0
11	3.0	98.1	0.0602	1.811	0.130	1.681	2.8258	.00339	.02353	.02632	2.236	4.2
11	4.0	97.2	0.0621	1.762	0.117	1.645	2.7060	.00325	.02303	.02628	2.363	2.4
11	1.5	92.8	0.0598	1.638	0.118	1.420	2.0164	.00242	.01988	.02230	2.682	5.0
11	3.0	74.7	0.0250	0.869	0.130	0.729	0.5314	.00064	.01021	.01085	2.304	2.4
11	4.0	71.2	0.0303	0.763	0.117	0.646	0.4173	.00050	.00905	.00955	3.173	4.2
11	2.0	71.6	0.0318	0.774	0.118	0.656	0.4303	.00052	.00919	.00971	3.275	5.0
13	10.0	114.0	0.0921	2.892	0.192	2.700	7.2900	.00875	.03780	.04655	1.978	2.3
13	10.0	89.4	0.0341	1.384	0.192	1.192	1.4209	.00171	.01669	.01840	1.853	2.3
13	10.0	61.7	0.0107	0.550	0.192	0.358	0.1282	.00015	.00591	.00516	2.074	2.3
13	2.0	41.9	0.0031	0.266	0.208	0.058	0.0034	.00000	.00081	.00081	3.827	1.0
14	10.0	111.9	0.1316	2.723	0.169	2.554	6.5229	.00788	.03576	.04359	3.019	8.0
14	10.0	89.4	0.0544	1.384	0.169	1.215	1.4762	.00177	.01701	.01878	2.897	8.0
14	10.0	61.0	0.0196	0.537	0.169	0.368	0.1354	.00016	.00515	.00531	8.691	8.0
15	8.0	113.4	0.0898	2.843	0.129	2.714	7.3658	.00824	.03809	.04684	1.917	2.1
15	10.0	89.6	0.0356	1.392	0.130	1.262	1.5926	.00191	.01767	.01958	1.818	2.2
15	10.0	61.5	0.0126	0.546	0.130	0.416	0.1731	.00021	.00582	.00603	2.090	2.2
16	10.0	110.1	0.1252	2.585	0.109	2.476	6.1306	.00736	.03466	.04202	2.980	8.6
16	10.0	87.6	0.0548	1.306	0.109	1.197	1.4328	.00172	.01676	.01848	2.965	8.6
16	10.0	59.4	0.0238	0.507	0.109	0.398	0.1584	.00019	.00537	.00576	4.132	8.6
17	4.0	110.5	0.1130	2.615	0.148	2.467	6.0861	.00730	.03454	.04184	2.700	7.2
17	4.0	88.7	0.0547	1.353	0.148	1.205	1.4520	.00174	.01687	.01861	2.939	7.2
17	4.0	59.5	0.0209	0.509	0.148	0.361	0.1303	.00016	.00505	.00521	4.012	7.2
17	5.0	111.5	0.1277	2.692	0.147	2.545	6.4770	.00777	.03563	.04340	2.943	9.3
17	5.0	88.5	0.0530	1.344	0.147	1.197	1.4328	.00172	.01676	.01848	2.917	9.3
17	5.0	59.6	0.0227	0.511	0.147	0.364	0.1325	.00016	.00510	.00526	4.315	9.3

TABLE No. 6.

COMPARISONS BETWEEN HOURLY EVAPORATIONS, COMPUTED AND OBSERVED.

Date.		Temp. of Water.	V	v .	$V-v$.	$1 + \frac{v}{2}$	Evaporation per hour.	
							Computed.	Observed.
							$(V.v)\left(1 + \frac{v}{2}\right)$ 60	
1885.								
June 23...	5-6 P.M.	70.2	0.738	0.275	0.463	2.9	0.022	0.020
	6-7	70.0	0.733	0.270	0.463	2.8	0.021	0.011
	7-8	69.9	0.730	0.295	0.435	1.9	0.013	0.011
	8-9	69.7	0.725	0.310	0.415	1.6	0.011	0.013
	9-10	69.5	0.721	0.307	0.414	1.7	0.011	0.020
	10-11	69.3	0.716	0.294	0.422	2.2	0.015	0.020
	11-12	69.2	0.714	0.281	0.433	2.3	0.016	0.020
June 24...	12-1 A.M.	69.0	0.708	0.289	0.419	2.1	0.014	0.026
	1-2	68.8	0.704	0.304	0.400	2.0	0.013	0.020
	2-3	68.6	0.699	0.293	0.406	2.5	0.017	0.020
	3-4	68.3	0.692	0.283	0.439	3.1	0.022	0.022
	4-5	68.2	0.689	0.287	0.452	3.3	0.025	0.022
	5-6	68.1	0.687	0.287	0.430	3.6	0.025	0.021
	6-7	67.9	0.682	0.267	0.415	3.0	0.020	0.015
	7-8	67.8	0.680	0.275	0.405	3.7	0.025	0.015
	8-9	68.0	0.685	0.280	0.405	4.1	0.027	0.015
	9-10	68.2	0.689	0.286	0.403	4.2	0.028	0.015
	10-11	68.3	0.692	0.294	0.398	3.5	0.023	0.015
	11-12	68.6	0.699	0.295	0.404	4.4	0.029	0.010
	12-1 P.M.	69.0	0.708	0.303	0.405	3.9	0.026	0.018
	1-2	69.5	0.721	0.313	0.408	3.6	0.024	0.018
	2-3	70.0	0.733	0.325	0.408	3.2	0.021	0.019
	3-4	70.1	0.735	0.335	0.400	2.9	0.019	0.020
	4-5	70.0	0.733	0.377	0.356	2.6	0.015	0.020
July 8...	5-6 P.M.	82.6	1.114	0.840	0.274	1.2	0.005	0.002
	6-7	81.8	1.085	0.811	0.274	1.3	0.006	0.006
	7-8	80.9	1.054	0.724	0.330	1.5	0.008	0.004
	8-9	80.0	1.023	0.670	0.353	1.5	0.009	0.010
	9-10	79.2	0.997	0.647	0.350	1.7	0.010	0.010
	10-11	78.5	0.974	0.644	0.330	1.6	0.009	0.010
	11-12	78.0	0.958	0.630	0.328	1.6	0.009	0.010
	12-1 A.M.	77.6	0.946	0.612	0.334	1.8	0.010	0.010
	1-2	77.2	0.933	0.613	0.320	1.9	0.010	0.010
	2-3	76.9	0.924	0.612	0.312	1.9	0.010	0.015
July 9...	3-4	76.7	0.918	0.606	0.312	1.8	0.009	0.015
	4-5	76.5	0.912	0.617	0.295	1.9	0.009	0.009
	5-6	76.4	0.909	0.653	0.256	2.0	0.008	0.011
	6-7	76.3	0.906	0.695	0.211	2.1	0.007	0.010
	7-8	76.4	0.909	0.749	0.260	2.0	0.009	0.010
	8-9	77.4	0.939	0.807	0.132	1.9	0.004	0.010
	9-10	79.0	0.990	0.806	0.184	1.9	0.006	0.003
	10-11	81.0	1.057	0.799	0.258	2.1	0.009	0.010
	11-12	82.5	1.110	0.791	0.319	2.2	0.012	0.002
	12-1 P.M.	83.3	1.139	0.784	0.355	2.5	0.014	0.010
	1-2	83.5	1.146	0.793	0.353	3.1	0.018	0.015
	2-3	83.0	1.128	0.780	0.348	2.9	0.017	0.020
	3-4	82.4	1.106	0.776	0.330	2.4	0.013	0.010
	4-5	82.0	1.092	0.700	0.392	3.0	0.020	0.020
	5-6	80.5	1.040	0.601	0.439	3.0	0.022	0.000
	6-7	79.0	0.990	0.611	0.379	2.0	0.013	0.000
	7-8	78.6	0.977	0.648	0.329	1.8	0.010	0.010
	8-9	78.3	0.968	0.656	0.312	1.6	0.008	0.015
July 10...	9-10	78.2	0.964	0.661	0.303	1.7	0.008	0.010
	10-11	77.9	0.955	0.669	0.286	1.8	0.008	0.015
	11-12	77.7	0.949	0.677	0.272	2.1	0.009	0.010
	12-1 A.M.	77.5	0.943	0.668	0.275	1.4	0.006	0.005
	1-2	77.3	0.936	0.637	0.299	1.4	0.007	0.015
	2-3	77.1	0.930	0.622	0.308	1.8	0.009	0.005
	3-4	76.9	0.924	0.622	0.302	1.7	0.008	0.010
	4-5	76.7	0.918	0.633	0.285	2.0	0.009	0.005
	5-6	76.4	0.909	0.652	0.267	2.0	0.008	0.014

TABLE No. 6.—(Continued.)

COMPARISONS BETWEEN HOURLY EVAPORATIONS, COMPUTED AND OBSERVED.

Date.		Temp. of Water.	V.	v.	V-v.	$1 + \frac{w}{2}$	Evaporation per hour.	
							Computed.	Observed.
							$V-v) \left(1 + \frac{w}{2}\right)$	
							60	
1885.								
July 10...	6-7 A.M.	76.4	0.909	0.670	0.239	2.0	0.008	0.006
	7-8	76.5	0.912	0.690	0.222	2.2	0.008	0.004
	8-9	76.7	0.918	0.793	0.125	2.9	0.006	0.011
	9-10	77.2	0.933	0.768	0.165	3.0	0.008	0.020
	10-11	77.4	0.939	0.631	0.308	3.8	0.019	0.010
	11-12	77.4	0.939	0.644	0.295	3.2	0.016	0.010
	12-1 P.M.	77.6	0.946	0.617	0.269	2.6	0.011	0.010
	1-2	78.5	0.974	0.698	0.276	2.7	0.012	0.000
	2-3	79.1	0.993	0.665	0.328	3.2	0.017	0.035
	3-4	79.1	0.993	0.593	0.400	2.8	0.019	0.010
	4-5	78.9	0.987	0.581	0.406	2.4	0.016	0.025
	5-6	78.5	0.974	0.596	0.378	2.2	0.014	0.012
	6-7	78.2	0.964	0.587	0.377	2.8	0.017	0.020
	7-8	77.8	0.952	0.565	0.387	2.2	0.014	0.013
	8-9	77.3	0.936	0.556	0.380	2.2	0.014	0.014
	9-10	77.1	0.930	0.549	0.381	2.3	0.014	0.006
	10-11	76.9	0.924	0.539	0.385	2.0	0.013	0.025
	11-12	76.6	0.915	0.523	0.392	2.1	0.013	0.010
July 11...	12-1 A.M.	76.4	0.909	0.513	0.396	1.6	0.010	0.010
	1-2	76.2	0.903	0.606	0.397	2.0	0.013	0.007
	2-3	76.0	0.897	0.510	0.387	2.2	0.014	0.018
	3-4	75.7	0.888	0.504	0.384	1.8	0.011	0.005
	4-5	75.5	0.882	0.497	0.385	2.0	0.013	0.010
	5-6	75.2	0.873	0.519	0.354	2.0	0.012	0.018
	6-7	75.2	0.873	0.543	0.330	2.3	0.012	0.012
	7-8	75.5	0.882	0.547	0.335	2.3	0.012	0.010
	8-9	75.7	0.888	0.543	0.345	2.2	0.012	0.010
	9-10	76.2	0.903	0.550	0.353	2.3	0.013	0.010
	10-11	77.1	0.930	0.562	0.368	1.8	0.011	0.010
	11-12	78.3	0.968	0.581	0.387	1.8	0.011	0.000
	12-1 P.M.	79.3	1.000	0.593	0.407	2.1	0.014	0.010
	1-2	80.0	1.023	0.595	0.428	2.1	0.015	0.010
	2-3	80.3	1.033	0.586	0.447	2.0	0.015	0.015
	3-4	80.0	1.023	0.542	0.481	2.0	0.016	0.010
	4-5	79.5	1.006	0.530	0.476	2.3	0.018	0.015

SUMMARY OF TABLE No 6.

HOURLY OBSERVATIONS.

	Computed Evaporation.	Observed Evaporation.
June 23-24.....	*0.482 in.	0.420 in.
July 8-9.....	0.241 "	0.242 "
" 9-10.....	0.265 "	0.255 "
" 10-11.....	0.321 "	0.280 "
DAILY MEANS.		
July .....28 days	7.08 "	6.34 "

* On June 23-24 there was a high wind, On July 8-9 the velocity of the wind was small,

TABLE No. 7.

COMPARISON BETWEEN DAILY EVAPORATIONS, COMPUTED AND OBSERVED.

Date.	Mean Temp. of Water.	V.	v.	V-v.	$1 + \frac{w}{2}$	Evaporation per hour.		
						Computed.	Observed.	
						$(V-v)\left(1 + \frac{w}{2}\right)$		
						60		
1885.								
July	4...	75.1	0.870	0.546	0.324	1.6	0.008	0.005
	5...	75.4	0.879	0.638	0.241	1.6	0.006	0.007
	6...	74.3	0.847	0.627	0.220	1.6	0.006	0.007
	7...	75.7	0.888	0.608	0.280	1.8	0.008	0.005
	8...	78.8	0.983	0.681	0.302	1.8	0.009	0.005
	9...	79.9	1.019	0.700	0.319	2.0	0.011	0.009
	10...	77.8	0.951	0.650	0.301	2.3	0.011	0.012
	11...	77.7	0.948	0.525	0.423	2.0	0.014	0.012
	12...	76.8	0.921	0.420	0.501	1.9	0.016	0.013
	13...	76.2	0.903	0.446	0.457	1.8	0.013	0.010
	14...	74.2	0.844	0.569	0.275	1.7	0.008	0.012
	15...	75.9	0.894	0.542	0.352	1.9	0.011	0.008
	16...	77.8	0.951	0.629	0.322	1.7	0.009	0.009
	17...	79.7	1.013	0.802	0.211	1.6	0.006	0.007
	18...	80.2	1.029	0.685	0.344	2.1	0.012	0.008
	19...	79.4	1.003	0.553	0.450	2.1	0.015	0.014
	20...	80.1	1.026	0.593	0.433	1.8	0.013	0.010
	21...	79.3	1.000	0.736	0.264	2.2	0.010	0.015
	22...	80.1	1.026	0.689	0.337	2.1	0.011	0.009
	23...	80.1	1.026	0.547	0.479	1.7	0.013	0.012
	24...	79.0	0.990	0.664	0.326	1.9	0.010	0.012
	25...	80.9	1.053	0.817	0.236	1.8	0.007	0.006
	26...	80.7	1.046	0.677	0.369	2.0	0.012	0.014
	27...	79.3	1.000	0.466	0.534	2.0	0.018	0.010
	28...	78.3	0.964	0.517	0.447	1.6	0.012	0.012
	29...	76.0	0.897	0.644	0.253	2.0	0.008	0.008
	30...	76.2	0.903	0.569	0.334	2.0	0.011	0.007
	31...	76.6	0.945	0.632	0.313	1.4	0.007	0.005
	Total.....	.....	26.819	17.172	9.647	52.0	0.295	0.263
	Mean.....	78.0	0.960	0.614	0.345	1.8	0.0104	0.0094

